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USSR Report

MACHINE TOOLS AND METALWORKING EQUIPMENT

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USSR REPORT

Machine Tools and Metalworking Equipment

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INDUSTRY PLANNING AND ECONOMICS

RECENT DEVELOPMENTS IN AZERBAIJANI METALWORKING INDUSTRY

Baku NARODNOYE KHOZYASTVO AZERBAYDZHANA in Russian No 10, Oct 85 pp 10-15

[Article by S. N. Akhmedova, Azerbaijani Design Institute, imeni Ch. Ildrym, V. V. Kalashnikov, I. A. Grigoryants, VNIIPTneftemash [All-Union Scientific Research and Planning Design Institute of Petroleum Machinebuilding]: "Technical Progress and Structure of Machinebuilding and Metalworking in the Azerbaijani SSR"]

[Text] The importance of accelerating the introduction of the achievements of science and technology as a decisive factor for increasing further the efficiency of social production was stressed in decrees of the 26th party congress and the 30th Congress of the CP of Azerbaijani. Great attention was given to the questions of realizing the achievements of science and technology in various sectors of the national economy in the November (1982) Plenum of the CPSU Central Committee and the Plenum of CP Azerbaijani Central Committee held in December 1982.

There is no other sector in the national economy that has so dynamic structures as machine building. The acceleration of the scientific technological progress depends, to a considerable degree, on the structure of this important sector of the national economy. At the same time, structural changes in the sector generate scientific technological progress induced by it.

Objective governing laws are a reciprocal influence between scientific technological progress and the structure of the sector.

In 1971-1980 considerable quantitative and qualitative changes occurred in machinebuilding and metalworking in the republic. A broad program was implemented in those years in the sector of modernization, expansion and reequipment of existing enterprises and placing into action new enterprises; a considerable amount of organizational-technical measures was developed and introduced.

As a result, the volume of gross production output in the sector for the republic as a whole increased 3.3-fold in 1980 as compared to 1970; while the annual average cost of basic industrial-production funds increased 2.6-fold and the productivity of labor -- 2.2-fold.

The rates of increase in the volume of production and productivity of labor in machinebuilding and in metalworking in the AzSSR exceeded general-union rates in respective sectors.

In 1980, the share of machinebuilding in the total volume of the gross output of the sector was 84 percent, while in metalworking, it was 28 percent. The change in the ratio between metalworking and machinebuilding was accompanied by a change in the structure of these subsectors.

The following were placed in operation during the 9th and 10th five-year plan periods: The Baku Air Conditioning Plant, the first in the country, was equipped with the latest machinery with a high degree of mechanization and automation of production processes; the Sumgaitsk Compressor Plant; new production buildings and capacities at the main plants of the "Azelektroterm" and "Azelektromash" associations, at the "Bakinskiy Rabochiy" Plant, at the Agdamsk Machine Tool Equipment Plant, at the Ali-Bayramlinsk Home Appliances Plant, etc.

Labor-intensive and lower metal content subsectors were developing at an accelerated rate which produced changes in the structure of machinebuilding.

As a result of the considerable development of young subsectors and the appearance of new ones, for example, the industry of intersector productions, the ratio of the oldest subsector in the republic petroleum machinebuilding, decreased and was 30.1 percent in 1980 as against 41.2 percent in 1970.

There is also a trend in the reduction of the ratio in such subsectors as the electrical equipment industry, etc.

At the same time, in 1971-1980, practically all machinebuilding subsectors in the republic developed.

In 1980, as compared to 1970, production volumes in the electrical equipment industry doubled more than slightly, in the petroleum machinebuilding, it increased 2.8-fold, in machine tool and tool building it increased 7.5-fold, in instrument building -- 2.5-fold, in agricultural machinebuilding -- 7.5 fold, in machine building for the light, food industry and production household appliances and machines -- 10.5-fold and in other subsectors --2.3-fold.

This increase in volumes of production during a comparatively short time was provided by the creation of new subsectors, as well as higher standards in the existing ones.

In 10 years, the number of mechanized flow lines functioning at machinebuilding enterprises more than tripled to 292, automatic lines -- to 43, or about quadrupled, comprehensively - mechanized shops and sections to 86, or more than 1.8-fold. Moreover, progressive equipment was introduced widely: automatic and semiautomatic machines, NC machine tools, machines for extrusion casting, etc.

In the 10th Five-Year Plan period, over 1100 new types of machines, equipment and devices were assimilated in machinebuilding, with over 200 of them for the first time in the country.

In the list of machinebuilding machines, equipment, tools, devices, automation and control facilities appeared which were previously not made in the republic. These are timing devices, home air conditioners, metal-cutting machine tools, equipment for separating petroleum and gas, thermal equipment, etc.

During the 10th Five-Year Plan period, the production output with the Emblem of Quality increased from 54.4 million rubles to 487 million rubles or almost 9-fold. Its ratio in total machinebuilding in the republic increased from 9.6 to 45 percent.

Machinebuilding successes in the republic transformed it into an important link of the national economy of the USSR.

However, as was stressed by Comrade K. M. Bagirov, Secretary of CP of Azerbaijani, at the Plenum of the CPAz Central Committee, held in December 1983, there is still a number of shortcomings whose elimination would facilitate a further increase in the efficiency of industry and the entire national economy of the republic.

These shortcomings are as follows:

lack of comprehensiveness in modernization and reequipment of individual enterprises, as well as the time of their implementation and, in some cases, the adoption of technically backward decisions;

slow introduction of powder metallurgy, low-waste and wasteless, resource saving technologies, incomprehensive reprocessing of raw and other materials;

low share of progressive kinds of machine tools, special, unit head, with NC, industrial robots and manipulators;

great obsolescence and physical wear of the equipment pool;

insignificant use of modern structural materials and plastics;

lack of initiative and persistence on the part of management of enterprises, associations and ministries in solving problems of renovation and improvement of technological equipment and contacts with union organs;

an insufficiently high level of labor mechanization and automation and, as a result, a high ratio of manual labor;

unsatisfactory utilization of available mechanized and automatic flow-lines;

too long a time is taken to develop and master new kinds of machines, equipment and devices, as well as there being a discrepancy between the requirements of today for the manufactured products on the basis of such criteria as productivity, metal consumption, reliability, etc.

The elimination of these shortcomings will facilitate further improvement in the structure of machinebuilding and metalworking in the republic.

Thus, at present, there has been no production of materials handling equipment. Yet, the requirements of the industry in the republic, including machinebuilding, are met only within 60 to 70 percent. For this reason, much materials handling and loading-unloading operations in machinebuilding and metalworking in the republic are done manually and the ratio of manual labor exceeds 50 percent. This is why it is necessary to create in the republic plants in the very near future for building materials handling equipment and to organize at these plants the production of universal and mobile mechanization facilities -- automobiles, electrical cars, conveyors, lifts and various kinds of crane equipment.

At present, national economic requirements of the republic, including machinebuilding, in instrument building are met only by 60 to 70 percent, while in some kinds -- 5 to 10 percent.

Yet, the ratio of this most important subsector in machinebuilding (without metalworking) in 1980 was only 3 percent and will increase in 1985 to 4.5 percent.

To supply the national economy of the republic with precise and highly sensitive devices for various functional purposes, it is necessary to build 2 to 3 new instrument-making plants.

An extremely serious problem is a further increase in the level of parts, units and, especially, in the technological specialization.

Today, there are only three enterprises specializing in the production of intermediate products (the "Elektrotsentrolit" Plant, the Baku Steel Casting Plant and the Kirovabad Casting Plant), whose ratio in the total volume of machinebuilding production does not exceed 2.5 percent.

Intermediate product production of machinebuilding in the republic is basically concentrated in small shops and sections of the enterprises themselves and their technical standard is extremely low. Thus, there are 27 cast iron shops in machinebuilding of which 15 have a production volume of less than 1000 tons of castings per year.

Cast steel production is concentrated in the shops of nine plants with the share of two small steel casting shops of about 2 percent of the total output of steel castings. Some 18 forge-press shops and sections product die forgings with five of them having an output volume of up to 1000 tons of forgings per year. There is also a low level of concentration of the production of structural metal.

There are 37 shops and sections in the republic that manufacture structural metal with nine of them having a production volume of up to a 1000 tons per year, 18 shops -- up to 5000 tons; 7 -- up to 10,000 tons and only three shops with a production volume of 5000 tons. Most of the small intermediate product shops are located in dilapidated and inadaptable buildings which it is

economically inexpedient to reequip. The production cost of one ton of cast iron in small or medium shops is 1.5 to 1.7-fold greater than in shops with a production higher then 10,000 tons. Steel casting production in the republic still hardy uses precision investment casting, die casting, etc. The output of steel castings in small shops per one square meter of area is 1/4 to 1/5 that of large shops. Casting productions are of low technical standards. The situation is similar also in the production of die forging where outdated equipment and imperfect mechanization facilities prevail. The basic technological facilities here are outdated and physically worn-out free forging hammers so that up to 40 percent of the stock is converted into chips due to the large allowances for intermediate products for machining, producing higher wear on the metal-cutting machine tools. The production cost of one ton of forgings in small shops is over 400 rubles as compared to 280-300 rubles in shops with a production volume of over 1000 tons per year. The insufficient quantity of centralized specialized production for manufacturing intermediate products necessitates large expenditures for obtaining them in cooperation from other regions of the country. Calculations show that eliminating the supporting of cast iron and steel castings and die forgings will make it possible to save 100,000 rubles annually just by eliminating transportation costs.

To improve and develop further intermediate product production in the republic it is necessary to prepare a comprehensive target program on this problem for the 12th and 13th five-year plan periods involving leading specialists in the republic. Prolonging the time for creating modern intermediate product productions in the republic delays the possibility for utilizing progressive metalworking equipment which requires precise intermediate products with smaller allowances. Calculations have established that the introduction of progressive intermediate products will increase the productivity of labor by 30 to 50 percent and reduce production costs by 20 to 40 percent and, in a number of cases, even more.

The concentration level of tool and fixture production in Azerbaijan is very low. Practically all machinebuilding and metalworking enterprises contain tool shops and sections where 15 to 20 percent of the metal-cutting equipment pool is concentrated. Most of these tool productions are characterized by high production costs.

The machinebuilding needs of the republic in hard alloy tool are not satisfied fully in volume and in the list of the products. Its share in the output of tool shops and sections does not exceed one percent.

However, it is precisely the hard alloy tools that make it possible to increase the cutting mode 3 to 10-fold as compared to tools made with high speed cutting steels and increasing thereby sharply the productivity of labor.

Yet, the share of hard alloy tools and fixtures mode by the Baku "Elektroshtamp" Experimental Plant of production does not exceed 5 percent under total volume.

Azerbaijan has only two plants for making tools and fixtures: the Baku "Elektroshtamp" and the Agdamsk Machine Tool Fixtures Plant.

K. M. Bakirov, First Secretary of CPAz Central Committee, stressed in his speech at the Plenum of the CPAz Central Committee held in December 1983, that in industry materials handling, warehousing operations, as well as repair works remain the "bottleneck."

Actually, in machinebuilding and metalworking each plant has its own repair facilities, while the sector has not one plant that specializes in the repair of metalworking equipment.

As a rule, machine repair shops and sections of plants are equipped with old universal equipment and the repairs (development, fitting, assembly, etc.) are done manually without efficient facilities for mechanizing, monitoring and regulating.

Thus, in the "Soyuzneftemash" All-Union Production Association repair enterprises, equipment more than 20 years old makes up 27 percent and in the instrument building enterprises -- 25 percent.

Small capacity and low technical and organizational level of repairs are the main reasons for untimely repairs, low quality of repairs and, as a result, of frequent idle times of basic equipment due to technical defects and high costs of repairs. Suffice it to say that labor expenditures, when repairs are made by plant repair shops, are 2 to 3-fold higher than when made by specialized repair enterprises, while the cost of production increased 1.5 to 2-fold.

Every year costs for all kinds of repairs of technological equipment in machinebuilding and metalworking in the republic are 30 million rubles and continue to increase due to the increase in the equipment park, more complicated design of machines and equipment and the intensification of their utilization.

In our opinion, it is necessary to begin building the following production facilities in the republic: an intermediate products complex, plants for the production of hard alloy tools and fixtures plants for repairs of metalworking equipment and for materials handling equipment, and an instrument building plant.

In the very near future, the republic will produce new kinds of machines and equipment: 200-ton steel melting electrical furnaces, dry transformers with windings impregnated with an epoxy compound, oil field and drilling equipment designed for operation under extreme conditions, i.e., at great depths, at high and low temperatures, in aggressive media, in the sea, etc. The technical standards of the enterprises of the sector will increase considerably. The realization of the achievements of science and technology, the acceleration of scientific technological progress will be accompanied by an improvement in the structure of machinebuilding and metalworking, by the liquidation of existing disproportions, and in this is the pledge of a further increase in the efficiency and quality of machinebuilding and metalworking in the republic.

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INDUSTRY PLANNING AND ECONOMICS

ADVANCED MACHINE TOOLS THANKS TO INTENSIVE INDUSTRIALIZATION

Frunze SOVETSKAYA KIRGIZIYA in Russian 23 Jun 85 p 2

[Interview of A. Beyshembayeva, deputy director, Kirghiz SSR Central Statistical Bureau, by KirTAG [Kirghiz Telegraph Agency] Correspondent S. Ogibalina: "In the Course of Technical Progress: Through Intensification Program"]

[Excerpts] The mastery of new processes helped the team at the Frunze Drill Plant to increase product output during the present five-year plan period without increasing the consumption of metal. Just by making precision drills by the grinding-out method has made it possible for the enterprise to save more than 60 tons per year of high-speed steel. This is sufficient to increase the output of tools by almost a million rubles worth. The efficiency measure is one of the assignments of the comprehensive program for speeding scientific and technical progress in the industries of the national economy of the Kirghiz SSR, which has been called upon to improve considerably the technical level of production, to improve its efficiency, and to ensure a further growth in labor productivity and a reduction in production costs. KirTAG Correspondent S. Ogibalina asked Kirghiz SSR TsSU [Central Statistical Bureau] Deputy Director A. Beyshembayeva to talk about how this program has been fulfilled.

"The majority of enterprises, departments, ministries and scientific research institutions of the republic have successfully introduced into production the achievements of science and engineering and have coped with their socialist obligations and counterplans. For example, last year in the industry, in addition to those in operation, two shops and six sections were totally mechanized; 32 automatic, semiautomatic and mechanized continuous production lines more than planned were put into service; and industrial robots and various automatic manipulators were installed."

"Quotas were overfulfilled for the introduction into machine building of such advanced methods as plastic deformation, powder metallurgy, the replacement of metals by other materials, the die casting method, etc. Twice as many as called for by the quota of the latest high-productivity machines and equipment appeared in shops, including machine tools with numerical program control and modular machine tools. At the Instrument Making Plant imeni the 50th Anniversary of the Kirghiz SSR, for example, the development of a mechanized assembly section utilizing robots, and the introduction of three

automatic thermosoftening units and two lines for forming parts, in which robots were also put into operation, made it possible to release 12 workers, and the monthly cost saving was greater than 11,000 rubles. The mastery of the achievements of scientific and technical progress is proceeding at an accelerated tempo at the Frunze Computer Plant. A robotic forging system has been created here, over and above the plan, and also a totally mechanized section and totally mechanized line."

"The utilization of modern scientific and technical developments in the industries of the national economy of the Kirghiz SSR has already produced no small return. For example, the frontiers of the 11th Five-Year Plan period for growth in labor productivity have been reached ahead of time in industry. The saving from the introduction of the achievements of science and engineering in this sector in 1984 equaled, according to estimates, more than 50 million rubles. The majority of labor collectives have successfully fulfilled the quotas set by the comprehensive program, their socialist obligations and counterplans, not only with respect to growth in labor productivity, but also with respect to improving product quality and lowering its production cost."

[Question] Are all managers and labor collectives ready to utilize the recommendations of scientists and specialists and to introduce scientific and engineering developments?

[Answer] "Unfortunately, far from all. Last year 17 enterprises and organizations of the republic did not fulfill 21 quotas of the program. Lagging behind in six of the most important measures has been observed in the current year. Minavtoshosdor [Ministry of Motor Vehicle Transportation and Highways], for example, did not solve one of the problems assigned. And, you know, just the creation of terminals--intermediate warehouses in Frunze and Osh for organizing the more efficient transport of freight--promises the industry a twofold increase in labor productivity and a threefold reduction of transportation costs."

"Among the deadbeats were Glavkirgizvodstroy [Kirghiz SSR Main Administration for Water Facilities Construction], as it has not yet mastered the laser equipment; the Kok-Yangak Mine, which has not constructed an energy-saving monorail; the republic's Gossnab's Kirgizmetallosnabsbyt Administration [Kirghiz SSR administration for supplying and marketing metals], which did not carry out the total mechanization of an important production section; as well as a number of other enterprises and organizations."

"The republic's scientific potential is still far from being used in the best manner. Not infrequently the efforts of scientists are dissipated on solving problems which cannot exert the necessary influence on fundamental changes in production. And the development of many important problems relating to intensifying the economy is being postponed. For example, in 1984 research and development were concluded on only 27 topics out of the 37 assignments of the comprehensive program, by the manpower of scientists of the academy of sciences, VUZ's and industrial scientific research institutes of the republic."

"The speeding of scientific and technical progress was emphasized at the recently held meeting in the CPSU Central Committee and it is an urgent, partywide and nationwide task. The attention and efforts of each worker and of all production and scientific collectives must be concentrated on solving these innovation problems."

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INDUSTRY PLANNING AND ECONOMICS

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STUDY REVEALS SIGNIFICANT UNDERUTILIZATION OF MACHINE TOOLS

Moscow MASHINOSTROITEL in Russian No 10, Oct 85 pp 39-40

[Article by G. G. Lyskova, engineer: "Experience in Raising the Shift Coefficient of Equipment Operation"]

[Text] Higher effectiveness of fixed capital is especially important under modern conditions. One-time studies of the use of equipment, made systematically by the USSR Central Statistical Administration, show that the shift coefficient of its operation has not exceeded 1.37 for almost two decades. In basic production where the relative share of high productivity machines and devices is high, the shift coefficient in 1983 was only 1.45, i.e., valuable equipment is underutilized. It is not by chance that the April (1985) Plenum of the CPSU stressed that managers of many ministries and enterprises have frequently taken an irresponsible attitude toward rational utilization of machine tools and machines, so that available equipment is idle at times or used only partially, and that it is necessary to fight such wastefulness.

It is important to improve the use of fixed production capital. It was calculated that an increase in the yield of fixed capital in the country by only 1 kopeck means an increase of more than 8 billion rubles in output.

Two basic factors effect the shift coefficient of equipment operation: the number of machine tool-shifts worked and the number of equipment units used in calculating this indicator.

At present, with the extremely limited inflow of personnel to enterprises, the basic means of raising the shift coefficient is the implementation of organizational-technical measures that make it possible to free machine tool operators for the second and third shifts. The greatest effect is produced by the development of multimachine servicing and the expansion of servicing zones as a result of which skilled machine tool operators are freed and it is not necessary to retrain them further.

The shift coefficient, when introducing multimachine servicing, as in other progressive forms of labor organization (combination of trades, brigade organization of labor), increases as a result of expanding the area of labor application per one worker. This, in its turn, is equivalent to an increase in the total number of machine tool operators and, therefore, also in the number of completed machine tool-shifts. Studies show that enterprises that allocate time for the development of progressive forms of organizing labor have, as a rule, a higher shift coefficient of equipment operation.

Of interest in this direction is the experience of a number of machine building enterprises in Leningrad. The turbovane shop of the "Leningrad Metal Plant" Turboconstruction Production Association increased the shift coefficient from 1.3 to 1.65 by increasing the number of multimachine servicing personnel by 20 percent.

Here are determined the indicators of the norm, plan and actual numbers of multimachine service operators for individual machine parks, taking into account their number, the shift coefficients and the servicing. When comparing the actual values of this indicator with norm indicators, reserves are detected in the organization of the servicing of the equipment. Taking into account these reserves, measures are developed for the further development of multimachine servicing and the combination of trades that provide for the necessary number of multimachine service personnel and the shift coefficient level set for the planned period.

The experience of leading enterprises in other industrial sectors can be utilized in machinebuilding. Purposeful work on combining related trades is being done at the Baku Tire Plant. Here, at the start of the year, shop managers present their ideas on the further development of combining trades. Then, an order is issued in the enterprise in which the reduction in a number of workers (according to an approved list) is determined. Every month the shop managers present the labor and wages department with a list of workers who can combine trades. They are trained for combination trades directly at the enterprises or in special courses.

The use of multimachine servicing and the combination of trades in brigades of the "Kaluga Turbine Plant" Association made it possible to free conditionally 12 percent of all workers in the association. As a result, the shift coefficient of equipment operation at the plant increased from 1.24 to 1.55 in three years.

The problem of the shortage of machine tool operators can also be solved to a certain extent by the organization of multiple skilled comprehensive brigades in which, by mastering related trades and providing full interchangeability, it is possible to redistribute workers in stages of technological process and thus do the planned volume of work with a smaller number of workers.

The creation of comprehensive multiple skilled brigades with equivalent links facilitates the interrelations between machine tool operators in shifts. At the Moscow Machine Tool Building Plant imeni S. Ordzhonikidze when such

brigades were organized at the end of 1984, about 60 percent of the total number of the machine tool operators began to work in the first shift and about 40 percent in the second shift (at the start of 1984, 80 and 20 percent respectively). As a result, the shift coefficient increased to 1.67 and the output-capital ratio increased by almost 2 percent.

Great possibilities in increasing the shift coefficient of equipment operation as the certification of work positions in the course of which the organization, conditions, productivity of labor level and technical conditions at each work position were evaluated comprehensively. The obtained data is used for following improvement of work positions, their reequipment taking into account the requirements of scientific organization of labor. At the "Volgograd Tractor Plant imeni F. E. Dzerzhinskiy" Production Association, as a result of certification in 1984, 274 ineffective work positions were eliminated which reduced personnel requirements by 450 persons, while the shift coefficient increased to 1.63.

Measures that also make it possible to free workers from other sections of the production facility have considerable effect in particular, from auxiliary sections (under condition of the timely retraining of personnel). Thus, at the Baku Machinebuilding Plant imeni Lieutenant Shmidt, as a result of the mechanization and automation of production processes and the introduction of progressive technology in 1983, 43 persons were conditionally freed, the greater part of whom, after training as machine tool operators, was transferred to basic production. Two almost equivalent shifts are functioning at the plant. The average shift coefficient in the plant is 1.71 and in basic production -- 1.74.

Similar work on improving the utilization of machines and devices is being done at many machinebuilding enterprises. Yet, as shown by statistics, the shift coefficient in most of them remains low. In this connection of great interest is the leading experience of enterprises and organizations where good solutions were found for this problem. For example, at the "Soyuzneftemash" plants of the VPO [All-Union Production Association], starting in 1975, systematic work is being done on raising the shift coefficient. A set of measures is developed and implemented every year on fuller utilization of the machine tool park. As a result, the shift coefficient in 1984 was 1.70 and in basic production -- 1.73. The idle time of equipment as compared to 1975 decreased by more than 14 percent and the output-capital ratio increased by 9 percent.

Uncovering reserves for effective utilization of equipment was facilitated by setting up norms for all machinebuilding enterprises of this association for the shift coefficient for 1981-1985. They were developed by the NVIIPTneftemash, coordinated with the "Soyuzneftemash" VPO, approved by the ministry and sent to plants as a goal for the 11th Five-Year Plan period.

Every year plants of the association, together with the institute, develop measures for reaching the planned shift coefficient. Among them a central place is occupied by measures directed to increasing the number of machine tool operators and the expansion of multimachine servicing: the introduction

of new progressive equipment, an increase in the number of machine tool operators graduating from technical schools; the training of workers for related trades; freeing auxiliary workers and transferring them to basic production. Great attention is given to modernizing outdated machine tools and the write-off of surplus equipment according to a list especially developed at the enterprise. Measures specify the servicing of shops in the evening shift by services of the chiefs of power engineering and mechanical departments, and the creation of necessary sets of spare parts before scheduled equipment repairs. Special attention is given to observing annual schedules for preventive maintenance, repairs and inspection in shops and sections, and the improvement of the quality of repairs.

The equipment shift coefficient calculation is made simultaneously with the preparation of the plans. The number of completed machine tool-shifts C is determined according to formula

$$C = P_{\text{Я}} + \sum_{1}^{P_m} P_m \times \Pi_m + \sum_{1}^{P_c} P_c \times \Pi_c + C_n,$$

where $P_{\text{Я}}$ -- apparent number of machine tool operators that service one machine tool; P_m -- apparent number of multimachine operators; Π_m -- number of machine tools serviced by multimachine operators; P_c -- apparent number of workers servicing machine tools in the process of combining trades (skills); Π_c -- number of machine tools, serviced by a worker in the process of combining trades, C_n -- number of machine tool-shifts, operated in overtime by machine tool operators.

By dividing the obtained calculated number of completed machine tool-shifts by the number of equipment, used in the calculation of the shift coefficient, the equipment shift coefficient is determined. This method is used for the daily operational account of the shift operation of metal-cutting machine tools and forging-press equipment. The number of completed machine tool-shifts in a 24-hour period is determined by cards accounting for the idle time of equipment, filled out by foremen at the end of the shift. The reasons for the idle time are indicated on the reverse side of the cards. On the basis of these cards, the economic service prepares a report on the utilization of the equipment for the past 24 hours by sections and shifts. It is given to the shop chief at 9A.M. the following day and is then sent to the production-dispatcher department of the plant, where a summary report on the shift coefficient is prepared for the enterprise as a whole (including basic equipment), which is presented daily to the plant management.

It should be noted, however, that the special accounting system requires additional working time on the part of foreman, engineers and technicians. Therefore, using the "Soyuzneftemash" VPO experience at other enterprises it is necessary to use more widely automatic accounting systems for machines and devices.

The coordination and development of organizational-technical measures at the higher management levels (ministry) will make it possible to achieve higher results simultaneously at many enterprises and will facilitate rapid solutions of problems related to raising the output-capital ratio and will ensure higher productivity of labor in machinebuilding as a whole. The experience of the Ministry of the Machine Tool and Tool Industry merits attention here. It developed a purposeful comprehensive sector program for improving utilization and increasing the shift coefficient of equipment for 1984-1985 and the period up to 1990. Methodological instructions were prepared for uniformity in analysis and the evaluation of indicators at enterprises, production associations, VPO and administrations.

The comprehensive target program for the sector specifies control values for the shift coefficient for the considered period for basic equipment and NC machine tools, eleven tasks on achieving the planned level of the shift coefficient at subordinated plants, as well as tentative values for the increase of this coefficient on the level of the sector. A special place in the program is given to the certification of work positions; the development of norm documents (methodological instructions) on this problem is specified, with help to be given to production associations and enterprises. According to the program, plans will be developed annually at all management levels (from the ministry to enterprises) on organizational-technical measures with schedules for their implementation, volumes of introduction and economic effectiveness. This will facilitate the achievement in the 12th Five-Year Plan period of shift coefficients for the ministry as a whole as follows: for basic production -- 1.15 and NC machine tools -- 1.90.

Thus, the implementation of the well-thought out organizational-technical measures and purposeful and systematic work on raising the shift coefficient will make possible the fuller utilization of the equipment and increase the effectiveness of production.

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INDUSTRY PLANNING AND ECONOMICS

MINISTRY OFFICIALS REPRIMANDED FOR DELAYING RECAPITALIZATION

Moscow IZVESTIYA in Russian 12 Nov 85 p 2

[Article under "USSR Committee of People's Control" rubric: "In Reference to the Article 'Drawing and Red Tape'"]

[Text] An inspection verified that the use of the new and promising rolling-drawing (PV) method developed by scientists from the Chelyabinsk Polytechnical Institute had been delayed for a long time by the irresponsible, formal-bureaucratic behavior of many administrators and officials of USSR Minchermet [Ministry of Ferrous Metallurgy] and Mintyazhmash [Ministry of Heavy and Transport Machine Building] and their subordinate enterprises and organizations, as the article "Drawing and Red Tape" (IZVESTIYA, No 232, 1985) accurately stated.

USSR Minchermet did not see to the timely resolution of problems connected with the financing and installation of the mill where the new technology was supposed to be perfected. When construction began at the Novosibirsk Metallurgical Plant (February 1972), the mill was not located in the sheet rolling shop as planned, but in the passageway leading to a facility now under construction--pipe welding shop No 3--outside the sheet and strip metal manufacturing cycle. Serious design defects and building errors were committed by VNIImetmash [All-Union Scientific Research, Planning and Design Institute of Metallurgical Machinery] and by the Starokramatorsk Machine-Building Plant of Mintyazhmash. All of this later precluded the normal testing of the "rolling-drawing" method.

The mill was not tried out until October 1974, 4 months after its start-up had been authorized. This initial test revealed more than 30 major flaws, many of which have not been corrected to this day.

The plant administration (A. Kalintsev, director) did not establish the necessary conditions for the testing of the mill and was unable to secure a timely and complete supply of high-quality rolled stock produced at the enterprise. Tests were conducted during a single shift, with 5-7 assigned staff members, instead of 75, and even these were frequently reassigned.

Nevertheless, even under these unfavorable conditions, the tests confirmed the superior features of the new technology. With a view to the test results, TsNIIchermet [Central Scientific Research Institute of Ferrous Metallurgy

imeni I. P. Bardin] provided the technical administration of Minchermet with recommendations on the practical use of the PV method in cold rolling in certain operations, particularly sheet dressing and trimming and mechanical descaling. In January 1980 the ministry awarded bonuses to workers at the Novosibirsk Metallurgical Plant and TsNIIchermet for the completion of assignments for the comprehensive study and mastery of the rolling-drawing process.

After this, the testing of the mill essentially ceased. Former First Deputy Minister A. Borisov, Deputy Minister N. Tulin, in charge of the operations of the Soyuzspetsstal All-Union Production Association and the Novosibirsk plant, and Chief V. Antipin of the technical administration, in charge of sectorial technical policy, effectively stopped overseeing this work and let it slide. Aware of the ministry's attitude, the Novosibirsk plant administration submitted a proposal in July 1984 regarding the cessation of tests and the removal of the mill.

Mintyazhmash and its subordinate VNIImetmash took the wrong position. In 1978 the institute relieved itself of all responsibility for the equipment it had designed. Furthermore, disregarding the results of the tests, its administration repeatedly expressed the opinion that the broad-scale use of the process in industry was an unrealistic prospect and effectively refused to participate any longer in the project. In the years since then, however, over 70 inventor's certificates have been issued for different varieties of the process and the equipment for it, many of which were patented in foreign countries.

There is a good example of this in our own country. The Zhdanov Metallurgical Combine imeni Ilich has been using the rolling-drawing method on its own initiative and deriving a considerable savings since 1977. The enterprise's expenditures on its incorporation were recouped in less than a year.

After investigating the results of the inspection to verify the facts cited in the article "Drawing and Red Tape" (IZVESTIYA, No 232), the USSR Committee of People's Control strictly reprimanded USSR Deputy Minister of Ferrous Metallurgy N. Tulin, Chief V. Antipin of the Minchermet Technical Administration and Director A. Kalintsev of the Novosibirsk Metallurgical Plant. They were warned that the failure to take decisive measures to correct the situation would be followed by their dismissal from their duties.

It was reported that USSR Minister of Ferrous Metallurgy S. Kolpakov and Minister of Heavy and Transport Machine Building S. Afanasyev had adopted a joint resolution on the remodeling of the PV-800 mill at the Novosibirsk Metallurgical Plant, the conversion of the existing "1700" skin pass mill at the Karaganda Metallurgical Combine for the PV process, and the remodeling of the "1200" four-high rolling mill at the Asha Metallurgical Plant for this process.

8588
CSO: 1823/058

INDUSTRY PLANNING AND ECONOMICS

UDC 669.053:621

MIX OF AVAILABLE METALS DISADVANTAGEOUS FOR MACHINE BUILDERS

Kiev TEKHNOLOGIYA I ORGANIZATSIYA PROIZVODSTVA in Russian No 4, Oct-Dec 85 pp 3-5

[Article by A. V. Kozenko, candidate of economic sciences: "The Efficiency of Metal Utilization in Machine Building"]

[Text] Machine building is one of the primary consumers of metal. Thus, about 30 percent of the total consumption of rolled products in the republic goes to machine building, taking its consumption in metallurgical distribution into consideration, and more than 50 percent without the metallurgical distribution.

The consumption of metal within an industry exhibits a number of features which are conditioned by the fact that modern-day metal working technologies are multi-operational and are characterized by the formation of a significant amount of waste, the presence of metal losses and the low level of its conversion into a useful product. The causes predetermining the low level of efficiency of metal utilization are an inadequate reproducibility of the requisite molds and parts dimensions in blanks, an inefficient (restricted) production structure, the low quality of the metal product and imperfection of the technological structure of mold-forming equipment.

As a result of the multi-operational nature of metal producing and mold-forming know-how, metal is primarily used in the form of an intermediate product (93 percent of total production volume), and only a negligable part of it is sent into the sphere of the final product. Of the total amount of product from intermediate metallurgical distribution (steel) only 50 percent of its yield materializes as machinery, equipment and other articles, a fact which is confirmed by the following data:

the technological consumption coefficient of steel in the production of the total amount of rolled products is of significang magnitude (1,213 in 1984), i.e. only 82 percent of the steel smelted in 1984 made it into subsequent metallurgical distributions;

the coefficient of metal consumption throughout all metal production (the extent of its conversion into finished products, taking into consideration processing wastes and losses) does not exceed 87 percent throughout the national economy of the republic on the whole, and 79 percent throughout machine building;

about 15 percent of the metal is consumed to insure an increased strength factor for the parts, mechanisms and designs (due to inadequately high physical and mechanical properties of the steel)

Thus, the efficiency of metal consumption depends on the metal content of the articles, their reliability and service life, the degree of conversion of the metal into a useful product, the amount of it in the tailings and the volume of non-recoverable losses. On the basis of these data, one may work out a system of quantitative indicators which characterize metal consumption and its efficiency. Such a system, which differs from the existing ones by virtue of its greater breadth of evaluative data, permitting the efficiency of metal consumption to be determined more precisely and the reserves for increasing it to be more completely identified, includes the following indicators:

actual metal consumption in production of a product with a prescribed reliability and service life;

additional metal consumption for production of items designated to make up for that part of output which was removed from operation before the standard deadline due to poor quality;

metal consumption on production of spare parts and keeping items which are in operation in good working order;

metal consumption designated to make up for that part which is removed from circulation as tailings and non-recoverable losses.

In the latter instance, the indicator characterizes dual expenses to the national economy: direct ones associated with metal removed as a result of being converted to tailings and due to non-recoverable losses and an additional investment of resources in the production of metal making up for its non-productive consumption.

By using the system which is being proposed, the efficiency of the utilization of ferrous and non-ferrous metals has been determined for the republic's economy and for its machine building sector (cf. Table). As may be seen from the Table's data, the level of metal utilization efficiency is determined by the quanitiy of metal production expended during the process of production and operations activities, the quantity of tailings and the size of losses in the mold-forming distribution, losses from metal wear and corrosion as well as the quantity of metal removed from use as a result of the means of production being retired from production prior to the standard service life being reached.

Dynamics of the efficiency of metal utilization within the economy and the machine building sector of the republic

Point #	Indicators	The economy			the machine building sector		
		1975	1980	1984	1975	1980	1984
1	Consumption of production of ferrous metals (in all)	100.0	100.0	100.0	100.0	100.0	100.0

Table (Continued)

Point #	Indicator	The economy 1975	1980	1984	the machine building sector 1975	1980	1984
1.1	In basic production	63.88	70.93	70.56	92.50	91.06	91.54
1.2	On repair and operations needs	36.12	29.07	29.44	7.50	7.94	8.46
1.3	To make up for items being removed from service before the standard deadline (based on points 1.1, 1.2)	3.00	2.55	2.55	3.00	2.60	2.40
1.4	To make up for metal being removed (total) (Based on points 1.1, 1.2)	12.21	10.93	10.61	19.61	19.76	18.80
1.4.1	Tailings for mold-formation of parts	10.69	9.42	9.12	18.32	18.58	17.70
1.4.2	Non-recoverable metal losses	1.52	1.51	1.49	1.29	1.18	1.10
1.5	Efficiency of ferrous metal utilization (based on points 1, 1.3, 1.4)	84.79	86.52	86.64	77.39	77.64	79.10
2	Consumption of production of non-ferrous metals (in all)	100.0	100.0	100.0	100.0	100.0	100.0
2.1	In basic production	97.99	97.49	97.33	91.21	89.98	87.85
2.2	On repair and operations needs	2.01	2.51	2.67	8.79	10.02	11.25
2.3	To make up for items being removed from service before the standard deadline (Based on points 2.1, 2.2)	2.49	2.50	2.60	2.49	2.49	2.38
2.4	To make up for metal being removed (total) (Based on points 2.1, 2.2)	18.68	18.59	17.93	19.04	19.64	20.16
2.4.1	Tailings for mold-formation of parts	15.07	14.53	13.88	18.33	19.05	20.01
2.4.2	Non-recoverable metal losses	3.61	4.06	4.05	0.71	0.59	0.65
2.5	Efficiency of non-ferrous metal utilization (based on points 2, 2.3, 2.4)	78.83	78.91	79.47	78.47	77.87	77.16

Table (Continued)

Point #	Indicator	The economy			the machine building sector		
		1975	1980	1984	1975	1980	1984
3	Efficiency of ferrous and non-ferrous metal utilization	84.67	86.32	86.64	77.19	77.66	78.96

9194
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INDUSTRY PLANNING AND ECONOMICS

BRIEFS

OPERATIONAL SHORTCOMINGS ACKNOWLEDGED, CORRECTED--The USSR Ministry of Machine Building for Light and Food Industry and Household Appliances discussed the article "Lengthy Closure" ("People's Control Record Sheet," No 9 [495]), which said that the Elektrobytpribor Plant in Ulyanovo had failed to fulfill the state plan for 4 years in a row. The criticism was acknowledged to be correct. Measures were taken to correct the situation at the enterprise. The plant administration was reinforced. The necessary quantities of monitoring and testing instruments, testing units and other means of production were manufactured. Today the plant is fulfilling the plan in terms of commercial output, sales and profit balance. [Text] [Moscow IZVESTIYA in Russian 12 Nov 85 p 2] 8588

CSO: 1823/058

METAL-CUTTING AND METAL-FORMING MACHINE TOOLS

UDC 658.274:629.113.002

DESIGN FEATURES OF NEW GENERATION AUTOMATED MACHINE TOOLS

Moscow AVTOMOBILNAYA PROMYSHLENNOST in Russian No 9, Sep 85 pp 37-38

[Article by D. F. Bryukhovets, candidate of technical sciences, MAMI: "Automatic Lines, Automatic Machine Tools and Semiautomatic Machines"]

[Text] The automatic nonsynchronous LA-1 line is designed to assemble four modifications of brake valves.

The products are assembled on satellite equipment with devices for limiting the speed of their movement. The modification of the assembled valve is determined by means of a regulated stop on the satellite that plays the role of a program carrier. The operating program of the automatic line depends on the interaction between satellite stop and the camshaft of the programer unit. The line has 23 positions including 12 automatic ones.

Specification of line

Number of manual operations	10
Valve assembly cycle, seconds:	
double-row	20-22
single-row	10-12
Air working pressure, megaPa	0.4
Technological air pressure in monitoring operations, megaPa	0.7
Control system	Autonomous for each automatic position
Size, mm	2300 x 3000 x 5000

Introduction into line at the Moscow Automobile Plant imeni I. A. Likhachev [ZIL] made it possible to free 25 assembly workers.

Developer and manufacturer -- ZIL.

The model SA-1100 (Fig. 1) automatic multipurpose assembly machine is designed for the simultaneous assembly of parts different in configuration and in number of machinebuilding products (from simple sets to more complicated

assembly units, consisting of 8 to 10 parts). The basic machine is an 18-position rotary table with a pneumatic rotational drive for turning the faceplate. Assembling is done in assembly-orienting jigs at all table positions. The parts are fed to assembly jigs from vibration bins and magazines. The product is assembled by the directional vibrations of the assembly orienting jigs by the action of the pneumatic turbulence devices. The machine can do the sequential, as well as sequential-parallel assembly of similar units.

Specifications of the automatic machine

Productivity, pieces/hour:	
sequential assembly	720
sequential-parallel assembly	?800
Size, mm	1800 x 1500 x 1?00
Weight, kg	300

Annual economic effect -- 10,000 rubles.

Developer and manufacturer -- ZIL.

The SA-1075 programable rotary table has a wide range of applications: automatic and semiautomatic technological systems for assembly, treatment and monitoring. Several fixed programs for rotating the face plate (with equal and different pitch within one rotation) are changed by readjusting the driving device which is equipped with a pneumatic jet control system. The drive for rotating the face plate is of a pneumatic turbulence type without rigid kinematic ties which guarantees full safety of the operation, especially in semiautomatic systems. A control system for changing the direction of the rotation of the face plate and the replacement of its rotation program is based on the use of pneumatic sensor pushbuttons that eliminate the possibility of an accidental connection of the program. The rotary table has 12 positions of the face plate. The face plate diameter is 50mm.

The introduction of one table saves 2000 to 3000 rubles.

ZIL is the developer and manufacturer.

The set of automatic equipment (Fig. 2) makes it possible to implement a comprehensive technological process for manufacturing ball pins (with plasma coating) for steering control of MAZ [Minsk Automobile Plant] automobiles which makes it possible to increase the service life of the pins 3 to 4-fold and eliminates the necessity of replacing the pins until capital repairs of the automobiles. The set consists of two automatic installations, one of which (model 5794) is designed for preparing the surfaces and spraying a plasma coating, while the other (model 5797) is designed for high frequency fusion of the coating with a following hot finishing of the spherical surface.

Specifications of equipment

Productivity, pieces/hour	180
Consumption, m^3/hour:	
plasma-forming gas -- nitrogen	3
compressed air	80
water	1
Sizes of installations, mm:	
model 5794	2500 x 2200 x 2200
model 5795	2400 x 1600 x 1500
Weights of installation, kg:	
model 5794	5100
model 5795	1200

Annual saving -- 700,000 rubles.

NIITavtoprom developer and manufacturer.

After milling, by a model AS-5952 automatic gear-gaging machine with a manipulator, gear wheel rims of thermally untreated gears of the frst and reverse gears of the GAZ-53 automobile are rolled (instead of shaved). This doubles the productivity of labor. The automatic machine is arranged conveniently. The machine tool is loaded by a manipulator. The system is controlled by a contactless automatic machine made by the "Tesla" Firm (ChSSR).

Fig. 1

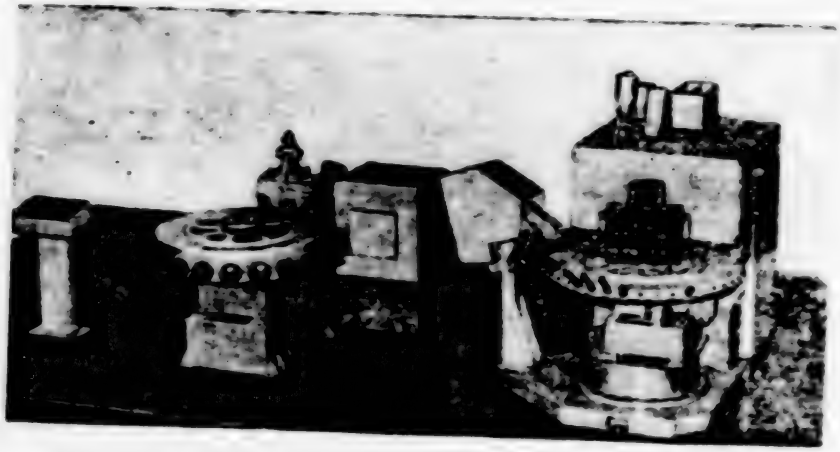


Fig. 2

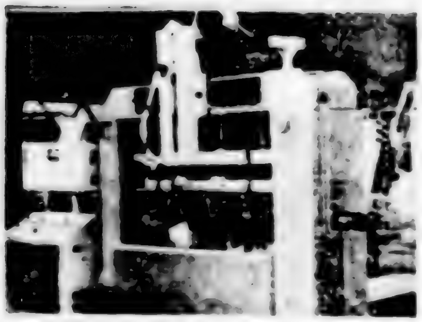


Fig. 3

Specifications of the automatic machine

Productivity (for 85 percent loading) pieces/hour	108
Diameter of machined gear, mm	169
Capacity of storage magazine, pieces	50

Feed force, kilonewtons:	
maximum	200
working	100
Revolution frequency of the roller (stepless regulation), min^{-1}	22-150
Motive power of main drive:	
type	Hydraulic, G15-23N
power, kw	3.4
Number of hydraulic cylinders	10
Number of electrical motors	3
Power of electrical motors, kw	8
Size (without cabinet for electrical equipment and hydraulic drive), mm	3700 x 1600 x 2900
Weight, kg	5000

Annual saving by introduction of one automatic machine -- 15,000 rubles.

Developer -- GAZ. Manufacturers GAZ and the Gorkovskiy Die Plant.

The model 1257 (Fig. 3) semiautomatic machine, designed for continuous operational monitoring of crankshafts after their preliminary machining according to 29 parameters, provides high precision and objectivity of monitoring and reduces the labor-intensiveness of quality control. The number of monitored points is double that of existing domestic analogs.

Specifications of the semiautomatic machines

Cycle of automatic operation, seconds	42
Limit of allowable error when monitoring, micrometers:	
width of journal necks	2
position of journal necks along the product axis	40
diameters of journal necks	15
diameters of front and rear reference necks	5
play in the front and rear supporting necks and the middle journal neck	20
Number of addressing kinds (acceptable, scrap "+", scrap "-")	3
Measurement method	Inductive
Working pressure in the hydraulic system, megaPa	4
Consumed power, kw	4.3
Sizes, mm:	
measuring station	2750 x 1780 x 3060
hydraulic station	430 x 820 x 1675
control panel with electronic unit	900 x 530 x 1780
Weight, kg	4700

The semiautomatic machine was introduced at the Yaroslav Motor Plant. The annual saving is 20,000 rubles.

NIITavtoprop is the developer and the Moscow Experimental Plant of the NIITavtoprom is the manufacturer.

2291
CSO: 1823/053

OTHER METALWORKING EQUIPMENT

UDC 658.52.011.56

NEW AUTOMATED MACHINING SYSTEMS RAISE PRODUCTIVITY, QUALITY

Moscow AVTOMOBILNAYA PROMYSHLENNOST in Russian No 10, Oct 85 pp 33-34

[Article: "Automatic Lines"]

[Text] Automatic lines are becoming one of the basic kinds of technological equipment at enterprises of the sector. They are highly productive, reliable and produce high quality products. Therefore, constant attention is being given to their development, manufacture and introduction by specialists of the machinebuilding sector.

Below are given several characteristics of such lines.

The model LA32 line is designed to manufacture the frame of an oil filter component for the VAZ automobile. The high level of its automation eliminated manual labor and production scrap and made it possible for one operator to run two such lines.

The line contains a straightening-uncoiling device to feed and cut off intermediate products, a welding machine, a device to feed tubes for crimping, a crimping device, a transporter for feeding intermediate products to the assembly conveyor, and electrical and pneumatic equipment.

Specifications of the line

Productivity (at 80 percent loading), pieces per hour	800
Operating cycle, seconds	3.72
Type of drive	pneumo-electric
Installed power of electric motors, kw	8
Size, mm	7200 x 2400 x 2540
Weight, kg	7600

The line has been being introduced at the Livenskiy Automobile Plant. Developer -- MKTEIavtoprom, manufacturer -- Experimental Plant of the MKTEIavtoprom.

The line for the longitudinal cutting of steel band rolls consists of a loading cart, coiler, trimming shears, rotary shears, coiling drum, hydraulic station and electrical equipment. It performs the following operations: sets up the roll on the drum of the coiler, unwinds the roll, cross-cuts the front end of the band, cuts the band longitudinally, coils the cut bands into rolls, cross-cuts the rear end of the band and removes the coiled rolls from the winding drum.

Specifications of the line

Thickness of cut tape ($\sigma_{вр}$= 450 megaPa), mm:	
maximum	2.5
minimum	0.5
Number of cutters for maximum thickness of band	6
Average cutting speed, m/min	12
Diameter of cutting rollers, mm:	
maximum	215
minimum	195
Sizes of initial roll, mm:	
outside diameter	1500
inner diameter	800
maximum width	620
Weight of roll, kg	6500
Sizes of a roll of cut bands, mm:	
minimum width of band	10
internal diameter	500
Total consumed power, kw	46
Size of line, mm	10500 x 5000 x 2300
Weight, kg	23,400

The line was developed, manufactured and introduced by the Ural Automobile Plant imeni 60th Anniversary of the USSR.

The model 4645 line is designed for abrasive rough grinding (six planes) of cylinder block castings for the KAZ-4540 automobile engine.

The principle of operation of the line is based on forcing the surface of the casting into contacting the face of the rotating abrasive disk. The line is equipped with devices for semiautomatic adjustment to the machined dimension and compensation for the wear of the abrasive disk. It is controlled by an electronic system. The castings are positioned when ground without the use of special devices.

Specifications of the line

Productivity, castings/hour	60
Size of ground casting, mm	530 x 640 x 455
Weight of ground casting, kg	160
Installed power, kw	220
Size of line, mm	12600 x 5000 x 3600
Weight, kg	50,620

The line has been introduced at the Kutaiss Automobile Plant imeni G. K. Ordzhonikidze; the economic effect is 180,000 rubles annually. The developer is the NIILTavtoprom.

The model AS-5440 molding operations in mass production casting shops for gray and malleable cast iron. It consists of the following: two molding blocks, a horizontal continuously moving floor conveyor, a knock-out device and a load conveyor. The molding block includes automatic machines for molding the upper and lower half-molds, equipped with manipulators for setting up and assembling molds on the conveyor, as well as for feeding empty flasks to the molding machines.

The line automates the molding process with minimal capital investments; labor productivity is increased and 50 molding workers are freed.

Specifications of the line

Productivity (cyclic), molds/hour	300
Flask size, mm	
inside	700 x 650
height	200/250
Conveyor pitch, mm	1250
Method of packing half-molds	Press by multi-plunger head with simultaneous high frequency shaking
Unit pressure pressing, megaPa	0.79
Strength of raw mixture, megaPa:	
on compression	0.06-0.08
on shear	0.01-0.02
Moisture of mixture, %	3.5 - 4.2
Drive	Pneumoelectrical
Size, mm	65,000 x 8800 x 3200
Weight, kg	280,000

The line was developed at the Gorkiy Automobile Plant; the economic effect is 650,000 rubles per year.

The model 66002 line is designed to roast molds, heat them to a given temperature, pack them with a hot filler, pour molten metal and cool the castings; it provides uniform heating that eliminates the formation of cracks in the molds.

Specifications of line

Productivity, blocks/hour	105
Maximum dimensions of blocks, mm:	
diameter	250
height	500
Temperature of basic material, K	973
Number of cassettes in conveyor, pieces	45
Power of electric motors, kw	40
Size, mm	22000 x 12000 x 4060
Weight, kg	80,000

The line was introduced at the Irbitsk Motorcycle Plant. Repayment time -- 3 years.

Developer -- NIITavtoprom.

The model KG-9402.055 line was designed for the zinc plating of steel clamps and other small parts (lengths of up to 80mm). It has devices to load bells automatically, unload them, move bells from one technological position to another, simultaneously stopping the bells at all work positions and rapidly lifting the bells from the pickling vat.

Specifications for line

Productivity, kg/hour	600
Thickness of plating, micrometers	9
Weight of parts loaded into bell, kg	25
Number of bells	44
Rate of bell output from vat, sec	150
Size, mm	23400 x 5500 x 4200
Weight, kg	57000

Developer -- EKTIavtoprom.

Transverse-wedge rolling of intermediate products for gear box shafts is used to obtain intermediate products, as well as consequent machining and for their preliminary heating and form-changing before subsequent die forging. It consists of induction heaters, a transverse-wedge rolling mill and an intermediate transporter.

The mill equipped with devices to measure the temperature of the intermediate products automatically rejecting them on the basis of the degree of heat and to feed them automatically; the line also has pneumatic and electrical equipment.

Unlike in existing mills, the stand of the mill is equipped with hinged wiring which makes access to the wedge rolling tool easier, while the tool design has special gibs that make it possible to roll products with a lower weight of the end wastes.

Specifications of the line

Size of initial intermediate products, mm:	
diameter	130
length	400
Productivity of rollers, pieces/hour:	
in one-revolution cycle	360
in two-revolution cycle with one feed stage	240
same, with two feed stages	180
three-revolution cycle with two feed stages	150
Nominal interaxial distance between rollers, mm	1100

Capacity of electrical motor of main drive of rollers, kw	110
Productivity of two heating installations, kg/hour	7000 - 8400
Heating temperature of intermediate products, K	1473
Size of line, mm	20800 x 13000 x 3200
Weight, kg	134,000

The annual saving from the introduction of the line is 88,400 rubles.

The developer is the GKTIavtoprom.

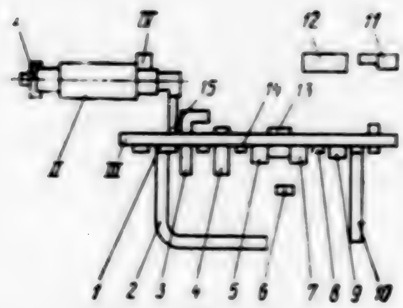


Fig. 1. Automatic assembly line: I -- device for loading intermediate products of pistons into furnace; II -- furnace for heating pistons; III -- automatic machine for assembling the connecting rod-piston group; IV -- device for unloading pistons from furnace; 1 -- device for loading pistons; 2 -- connecting rod storage; 3 -- device for insertion of piston pins; 4 -- device for installing stopping rings; 5, 7, 13 -- devices for installing piston rings; 6 -- central control panel, 8,14 -- monitoring devices; 9 -- mechanism for unscrewing nuts of connecting rod bolts and shift the connecting rod cap; 10 -- storage for assembled products; 11 -- electrical equipment; 12 -- hydraulic station; 15 -- device for orienting pistons.

The assembly line for assembling a connecting rod-piston group of the KamAZ automobile engine (Fig. 1) is a sequential row of devices and storages, located along a transport system in assembly positions.

The assembly is done on a two-place satellite. Each line position is monitored by an individual control panel, while the operation of the entire line is monitored by a central panel.

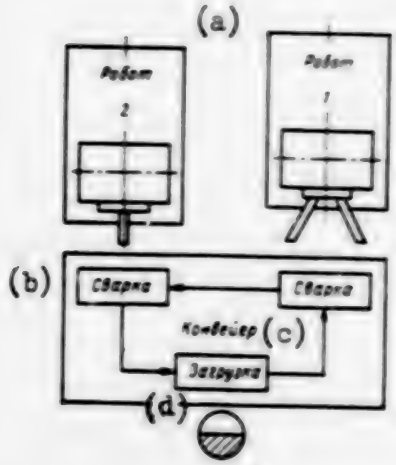


Fig. 2. Automatic line for assembly-welding of recess of cover of a tool box

a -- Robot; b -- Welding; c -- Conveyor; d -- loading.

Specifications of the line

Productivity, pieces/hour	514
Installed power, kw	100
GControl	automatic
Signaling	light
Size, mm	1600 x 9000 x 2500
Weight, kg	18,000

The annual saving from the introduction of one line at KamAZ was 327,000 rubles.

MKTEIavtoprom was the developer.

The line for assembling gear boxes for the KamAZ automobile consists of a system of transportation facilities, stands, impact wrenches, a coding device and readers.

The introduction of the line made it possible to mechanize positions for installing the gear box, pressing the oil seal of the clutch shaft, punch nuts of the Cardan shaft, as well as automate the positions for plugging the gear box covers.

Specifications of the line

Productivity, pieces/hour	42
Number of modifications of assembled boxes	7
Number of assembly operations	42
Number of positions	50
Number of automatic positions	16
Number of operators servicing the line	26
Size, mm	60600 x 5970 x 3740
Weight, kg	90,000

The introduction of the line provides for an output of 125,000 boxes per year and frees four assemblers. The economic effect of introducing the line is 44,000 rubles per year.

The MKTEavtoprom is the developer.

The line for assembling and welding the recess and covers of the tool box of the automobile (Fig. 2) consists of a horizontal roller conveyor over which travel three satellite carts, and two robots one of which is equipped with a single and the other -- with double welding claws with a distance between them that can be regulated.

Robot 1 welds 13 pairs of points on the cover in 36 seconds and 16 pairs of points in the recess in 58 seconds; robot 2 welds 14 points on the cover in 45 seconds and 9 points in the recess in 27 seconds.

The change in robot program is made by two-position switch.

Specifications of the line

Productivity, parts/hour	60
Coefficient of loading,	0.8
Power, kw:	
electrical equipment	40
welding equipment	510
Size, mm	4000 x 5100 x 6000

The introduction of the line at KamAZ raised the productivity of labor considerably, improved working conditions, freed six welders and production areas.

The annual saving was 22,000 rubles.

2291
CSO: 1823/052

OTHER METALWORKING EQUIPMENT

ELECTRO-EROSION ATTACHMENT DEVELOPED FOR NC MACHINE TOOLS

Tallinn SOVETSKAYA ESTONIA in Russian 8 Aug 85 p 1

[Article by Ya. Dmitriyev: "Numerically Controlled Machine Tools at "Pioneer" Factory Operate Automatically"]

[Text] Specialists at the Pioneer experimental machine tool factory recently adopted yet another innovation. Electro-erosion polishing of molds was introduced in the numerically controlled [NC] machine tools section. This is a fundamentally new polishing technology, which makes it possible to achieve ideally clean, mirror-finished operating part surfaces. Thereby, another step was accomplished toward creating a technical center for operation of NC machine tools in the republic's Minmestprom [Ministry of Local Industry], to serve many Baltic region enterprises.

"This is in the future, although is probably not so far off," V. Frishman, the main engineer of the Pioneer factory tells us. "But our immediate task is to progress beyond the confines of a single section, which now numbers nine machine tools, and create a shop furnished with modern NC equipment, so that at least a third of our products will be manufactured using this latest technology."

We observe one of the new machine tools operating in the section. An electronic spark, which forms at the point of contact of an ultra-thin brass wire with a steel bar, cuts the metal so cleanly (and on three surfaces) that it is doubtful an expert could machine with such accuracy. It is accurate to a thousandth of a millimeter; a size visible only under a microscope. But this is only one of the characteristics of the new equipment. It operates automatically, based on prior programming.

A. Myark, chief of the NC machine tool office, and A. Mets, an electronics engineer, demonstrate for their guest the process of creating such a program.

The operator, with a drawing of the part before him, sets up its parameters on the keyboard of an instrument resembling a typewriter. With the aid of a kind of translation dictionary (an operating disk placed in a programming device) this numerical language is translated into machine language and the lines of the drawing appear on the display. The machine itself indicates the machining system, specific device and type of machine tool required. Several tens of

minutes later the machining program is ready. All that is left to do is to transfer it to punch tape, which is also accomplished automatically by pressing the appropriate key.

"Labor productivity in the NC machine tool section," continues Frishman, "is twice as high as the average for the factory's metalworking equipment. But, it is not only a matter of productivity. Our factory was starting to lose the most experienced milling machine operators, polishers and fitters. The intensity of work in manufacturing molded parts on conventional equipment was so high that few could stand it.

"Now the operator (not "machine-tool worker" but expressly "operator") is a man who controls electronic equipment; a specialist with at least secondary education. On no other machine tool -- milling, jigging or drilling -- can such accuracy be achieved. And accuracy in manufacturing of molds is a top priority requirement. After all, the quality of the finished product depends on these molds."

We examine plastic parts with tiny holes, notches and protrusions -- holders for phonograph needles manufactured by the RET association; Salvo children's combs with extremely fine designs on the handles (engraving work, in truth!); and components of Normy safety belt locks, It turns out that the stamps for the lock parts had been purchased abroad, at a cost of tens of thousands of foreign currency rubles.

"This, as you see, is also a savings and no small one," emphasizes the chief engineer, "although not for us, but for the purchaser, which is especially important."

A characteristic detail: One does not see a single older worker in the NC machine tool section or office; all, without exception, are young.

"This is not surprising," states A. Myark. "We believe that primarily the young specialist, a secondary school or VUZ graduate, is best able to learn to operate this equipment. The older worker, no matter how highly qualified he may be, finds it extremely difficult to adapt to the new equipment. After all, here it is most important to be able to feel (if it can be so stated) the electronic essence of the equipment."

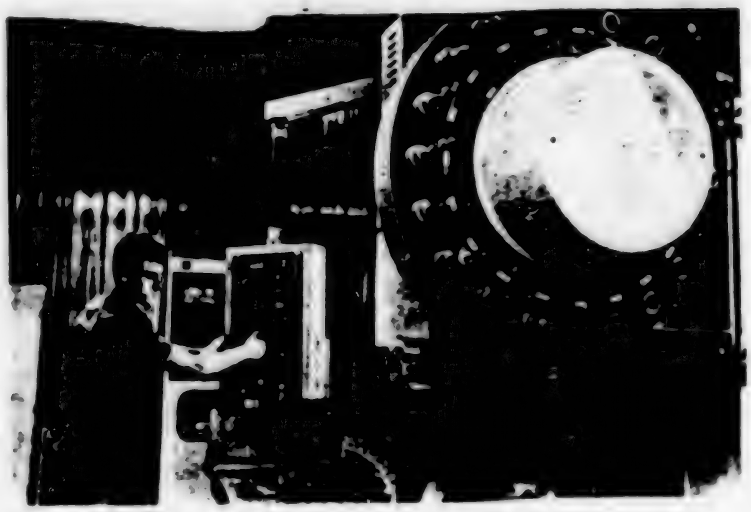
"And who trains the operators, electronics engineers and mechanics?"

"Much thanks should be given to the instructors at TPI [Tallinn Polytechnical Institute]," emphasize the factory managers. "Good mechanical engineers are turned out at that VUZ."

Allan Myark and Ayvar Mets, with whom we are already acquainted, Sergey Zinevich, Oskar Ront and Igor' Volgin are all recent graduates of TPI. They are now well integrated into the factory collective. And operators Ayn Kaur and Nikolay Balashkin are a good match for the young engineers.

Well, OK. The equipment is ultra-modern, but is also costly. How fully is it utilized? In listening to the answer to that question I learn yet another

interesting detail. The electro-erosion cutting tools, for example, operate automatically at night as well, with no particular need for servicing personnel. The coefficient of their utilization is 400 hours of machine time per month (one shift is 170 hours). On the average two people in the section compile this index. Two work shifts is considerably more than at a number of other enterprises in the republic which also have such equipment.



The new equipment has been well integrated into the manufacturing process of the experimental enterprise, proving in practice its high effectiveness even in self-contained production such as the manufacturing of machine tools.

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OTHER METALWORKING EQUIPMENT

PRODUCTION DELAYS DUE TO SHORTAGE, POOR QUALITY OF CUTTING TOOLS

Moscow RABOCHAYA GAZETA in Russian 29 Mar 85 p 3

[Article by RABOCHAYA GAZETA special correspondent I. Naumenko, in Lvov, under the rubric "Lessons of Economic Thought": "The Impact of Cooperation"]

> [Text] "Tools." That was the title of an article published in our newspaper on December 6, 1984, in which we spoke of how inefficient tool production has been in the machine-building enterprises' own shops. And although the situation was analysed on the basis of examples from plants in Kharkov, the editors received responses to the article from other industrial centers of the republic as well.
>
> Thus, first secretary of the Lvov obkom [oblast party committee] of the Ukrainian Communist Party, V. F. Dobrik, noted the problem's currency and informed us that an interdepartmental scientific industrial machine-building complex, based on the UkSSR Academy of Sciences' Western Center, has been developed, and that the so-called Instrument Association has been organized within its framework. This association is occupied with the coordination of tool-production processes in Lvov and oblast plants, with prolonging the life of tools and attachments, and the introduction of new designs and methods based on a single technical policy, i.e. overcoming interdepartmental barriers that interfere with the growth of the tool stock's effectiveness.
>
> Today we will tell about the Lvov experience.

Telephone number 39-56-70. These days toolmakers from virtually all the machine-building enterprises in Lvov know this number -- people who are seriously concerned with introducing the latest technology for ruggedizing tools and attachments: the application of durable coatings on "Bulat"-type installations and the vibration, acid-inhibiting machining of milling cutters, broaches, etc.

Was it accidental that Lvov toolmakers took up ruggedizing tools so actively? Not at all. Like all the republic's machine builders, they are experiencing the most serious shortage of tools and attachments. What this leads to is obvious if only from such an example as the following. Many years ago,

specialists from the Lvov Avtopogruzchik GSKB [Special State Design Bureau] developed a design for a hydraulic truck crane which was capable technically of competing with products put out by KATO, a Japanese firm known worldwide. Yet the Drogobych Truck Crane Plant still has not been able to launch production of the innovation. One of the reasons for this is the absence of the many gaskets and seals needed for a hydraulic system to operate. Theoretically, the Belotserkovskiy Industrial Rubber Plant is undertaking to manufacture all these parts. But only on condition that the Drogobych machine builders give them the appropriate dies. And where are they to get them? Specialized plants belonging to USSR Minstankoprom [Ministry of the Machine-Tool and Tool-Building Industry] are overloaded with orders as it is. And to manufacture the dies using their own forces is not possible, given tool-stock capacities.

The well-known Lvov Bus Works (LAZ) turned out to be in a similar situation when in 1982 it began introducing a new brand of bus with a diesel engine. In spite of the fact that the Lvov auto workers were being helped by toolmakers of the Zaporozhye Motor Vehicle Works (AvtoZAZ), the Kama Motor Vehicle Works (KamAZ) and the Pavlovsk, Likino and Riga bus works, when a new model in the series was being launched, the available supply of attachments amounted to only 58.3 percent of what was needed, and only 58.7 percent of the needed tools. As a result, many technical operations were in fact being performed manually or using semi-primitive methods.

Meanwhile, the capacities of the toolmaking shops in Lvov Oblast machine-building enterprises -- as in other enterprises, as a matter of fact -- are not all that small. But because of small-series production and inefficient station and equipment workloads, their labor productivity is 4.5 times lower than in Minstankoprom's specialized plants. And can we really consider it normal when in the same Lvov industrial region the work-shift coefficient in the toolmaking industry goes no higher than 1.2, and the equipment workload is 60 percent? If we take into consideration that a substantial part of both labor and technology is used for manufacturing state-standardized [gostirovannyy] cutting tools (up to 40 percent at the same Lvov Bus Works!), then the interest in prolonging the service life of these tools is understandable. The machines and workers who are freed because of this may be used for manufacturing special tools and attachments.

Well, now let's come back to telephone number 39-56-70. This phone was installed in one of the laboratories of the Lvov Physico-Mathematical Institute of the UkSSR Academy of Sciences at an information center for learning how to handle the "Bulat" installation. The main consultant is a young, beginning scientist, Ya. V. Shuyko. He has grasped "Bulat's" subtleties excellently.

"It's hard to list the questions we're asked," says Yaroslav Vladimirovich. "We help repair various 'Bulat' centers, literally over the phone. We pass on the addresses of organizations with advanced experience. And we help with introducing the 'Bulat,' of course not by phone but by going out to the enterprise and concluding economic agreement [khozdogovornyye] topics for research work."

We will add that, thanks to the lively activity of this information center (by

the way, not only institute scientists work in it, but also specialists from enterprises that have adopted the installation), all the enterprises in Lvov Oblast that have the "Bulat" are working efficiently. The toolmakers of other industrial areas of the republic can hardly boast of the same.

The impact of regional cooperation in introducing new tool-ruggedizing processes in the Lvov area amounted to 500,000 rubles in 1984 alone. That is quite a figure. But here is a worker's opinion. Speaking is a milling machine operator from the Lvov Tool Production Association, Yu. A. Chernyy:

"I service 13 machines. And only because the service life of milling cutters machined by 'Bulat' has increased by several times. Naturally there are fewer readjustments. So we gain. In time and quality. And it's nice to work with a dependable tool."

In the tool stock of any enterprise, one will find many articles for which there is only an occasional need. Let's say we have to drill a hole 70 mm in diameter. The drill we need is not handy. It was manufactured at the expense of a considerable amount of labor and machine time. But then the same drill can sit for years gathering dust on the shelves of a warehouse. Or a large-size linear angular measuring tool. A sliding caliper up to two meters long, a micrometer of one-half meter and more. How many of them are piled up, unused, in plants?

In the Instrument Association they had the idea of organizing a rental center for rarely used measuring and cutting tools. It was developed in the rental division of Lvovelektromashsnabsbyt [Lvov Electric Machine Supply and Sales Organization], which has considerable experience in giving enterprises this kind of help -- renting out complex electronic and radio apparatuses.

"We are just introducing this new type of service," explains division chief V. A. Kovalenko. "In the near future we could have 300,000 - 400,000 rubles worth of measuring tools alone in circulation. But we need a repair center right away so that the new child doesn't become 'dystrophic.' You'll agree -- without that, renting is unthinkable. Because after they're used, cutting tools have to be resharpened and restored. Measuring tools have to be checked and, when necessary, repaired."

UkSSR Gossnab [State Committee for Material and Technical Supply] supported the Lvov people's undertaking and is prepared to allocate appropriate labor quotas. The matter is held up by a search for production area. Now it is up to the Lvov gorispolkom [city soviet executive committee]. And the gorispolkom is close to having the possibility of allocating the space: from day to day the No. 3 Textile Mill is supposed to move to a new building. Why not turn the vacant premises over to the intersectoral renting center for rarely used tools for a repair facilities? All the more so, consider the specialists, since this innovation deserves all possible attention. Here is the opinion of an engineer, chief of the experimental divirion of EKTIAvtoprom [not further identified], L. D. Yakovenko:

"Recently we needed to manufacture a vacuum chamber for research work. Just

one. We required a large-size vernier caliper, literally for only a few days. It used to take a month to find out who had one when we needed to borrow one from somebody. Otherwise we'd have to buy it outright. We took advantage of the rental system. It was both convenient and advantageous."

And finally, here is a figure: according to the most conservative estimate, the rental of rarely used tools in Lvov alone could mean an annual savings to the state of up to 500,000 rubles.

The Lvov intersectoral Instrument Association today is made up of 17 machine-building enterprises, scientific-research and educational institutes and other organizations. And although right now possibilities are being studied for each to contribute its part to raising the effectiveness of the tool stock of the area, at the same time considerable practical steps are already being undertaken.

Thus, LIPO [Lvov Toolmaking Production Association] of USSR Minstankoprom is rendering its services to all the city's enterprises, regardless of their departmental subordination, for heat treatment of the tools and attachments they have manufactured. With absolutely no loss to its own production. Last year, for example, orders to temper 50 tons of different tool items were filled for different enterprises.

There is one detail here. The LIPO heat-treatment furnaces work without interruption. They stop only for servicing. In other plants, similar equipment is turned on when it is needed. But for a furnace to reach the right temperature, it has to be heated for at least 24 hours. Naturally, in this process electrical energy is wasted. So, thanks to the heat-treatment services rendered by LIPO, Lvov plants have saved 250,000 kWh of electrical energy in the manufacture of tools and attachments.

"At first," says LIPO chief engineer G. V. Lukyanenko, "our clients were cautious. Better a bird in hand than two in the bush, as they say. But gradually they developed a taste for it. And it's understandable -- being a heat treater is a special job. You have to have constant training. And if a man is working with heat treatment, from time to time -- say two-three times a week, defective output is inevitable. Our specialists are first class. So the quality of heat treatment is excellent."

Theoretically, LIPO's heat-treatment shop could accept orders for up to 200 tons a year. Because there is a definite capacity potential here. So what are the thoughts about regional cooperation among enterprises whose tool stock is already overloaded today?

"It's all in utilizing the potential we have," says candidate of technical sciences V. M. Golubets, Instrument Association chairman and division head of the Lvov Physico-Mechanical Institute of the UkSSR Academy of Sciences. "If we efficiently organize the toolmaking industry, which is already intersectoral by its nature, we can at least double the yield of existing capacitites and labor resources in our region."

What does he have in mind? Take as an example specialization on a principle of technology. At the moment in many of the city's enterprises, there are electric-discharge machine tools with NC (numerical control). But they, as a rule, are standing idle. Either there is no programmer, or there are not enough adjusters. Meanwhile, small press molds are being manufactured by hand. But if the existing electric-discharge NC machines were pooled in one section, the effect would be enormous. For it takes several days to manufacture a complex press mold using ordinary methods, but only 2-3 hours with the help of an integrated set of machines!

Besides the technological principle, intersectoral cooperation can be achieved on the basis of the item being produced. Having studied the potential of each enterprise individually, specialists of the intersectoral communications department of the Lvov division of the UkSSR Academy of Sciences Economics Instutute have come to the conclusion that in the toolmaking shop of the Lvov Bus Works, let's say, it would be advantageous to organize the production of cutting tools for the whole region. In the Avtopogruzchik Association -- measuring tools, in the Lvov Motorcycle Plant -- small dies and molds, etc.

But how do we put all these recommendations into practise? For the development of specialized shops and sections, although additional capital investments will not be required, both labor and material resources will have to be redistributed among enterprises of different sectors. In practise, this is being implemented at present. But only in a veiled form. As the notorious formula goes: you scratch my back and I'll scratch yours. Naturally, neither the workers nor the machines will be moved, although they will be used for carrying out someone else's requests. But the plant that does not possess what another requests in return will receive nothing from such a partnership. So would it not be still more convenient in fact to develop regional intersectoral specialized sections?

Not without interest in this connection is the opinion of Professor I. M. Petrovich, scholar, economist and department head of the Lvov division of the UkSSR Academy of Sciences Economics Institute:

"The fact that we need regional intersectoral specialization in the toolmaking industry is understood by everyone today. However, enterprises do not have the right to redistribute funds independently even on the intrasectoral level -- not to mention the intersectoral level. That is to say, appropriate normative acts are necessary.

"Nobody is talking about basic production. Or about ancillary production in full volume, including the toolmaking industry. But enterprise directors should have the right to determine how to use a part of the ancillary production resources, let's say in a range of 20-30 percent, at their discretion -- of course, under the control of the planning commissions of the oblispolkoms [oblast soviet executive committees]. The directors should also confirm the assignments of specialized sections and shops, taking into consideration the interests of all the consumers making up the region. Clearly the time has come for Gosplan [State Planning Committee] and Gossnab to be given the appropriate authorizations."

As we see, the birth of intersectoral cooperation in the toolmaking industry in Lvov is not without obstacles and problems. But already in the next year or two, judging from the first steps and rough drafts, it will yield a perceptible national economic result measurable in over 1 million rubles. And if we abolish interdepartmental barriers and adopt normative acts which legitimize regional cooperation, then the output will increase over and over. For then the Lvov Instrument Association, now functioning on a voluntary service principle and on the initiative of individual industrial managers and local party organs, will receive the material and legal basis for their activity.

Why does the Lvov experience, though still at a beginning stage, deserve our attention? Well, first of all because in many other industrial areas of the republic the task of intensifying the toolmaking industry is regarded slightly differently. Thus, in a response to the editor following the article "Tools," the secretary of the Dnepropetrovsk party obkom, A. A. Mironenko, expressed the opinion that in practise all tools put out in large volume, even specialized ones, should be produced by USSR Minstankoprom. The Zaporozhye party obkom, as is clear from a response from obkom secretary V. V. Adzerikho, recommended that oblast enterprise executives appeal to the higher economic organs on questions raised by RABOCHAYA GAZETA. The Donetsk obkom took almost the same position, as was clear from the response of obkom secretary V. G. Kurcherenko.

Incidentally, as the response to the article "Tools" by Minstankoprom Deputy Minister I. N. Ordinartsev testifies (RABOCHAYA GAZETA, March 22, 1985), the USSR Ministry of the Machine-Tool and Tool-Building Industry is carrying out a great deal of work to satisfy the demand of the national economy for this production. The machine-building minstries themselves are not standing on the sidelines, either. However, the experience of the people of Lvov convinces us that the effectiveness of the tool stock can be raised by the industry's own forces as well, if, of course, party and soviet organs carry out organizational work in this direction. For it was on the initiative of the commission on assisting technological progress of the Lvov Oblast committee of the Ukrainian Communist Party that the Instrument Association came into existence.

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AUTOMATED LINES AND AGGREGATED MACHINING SYSTEMS

FLEXIBLE PRODUCTION SYSTEMS IN CEMA COUNTRIES VIEWED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 16 Mar 85 p 3

[Article by A. Poplekhin: "The Impact of Cooperation"]

[Text] Not long ago there was a meeting at which Czech developers from the Inpro Company in Prague defended their design for an integrated robotized section. It was built for the Vitebsk Tool-Grinding Machine Plant. It is not so long since the CEMA Executive Committee adopted its decision to organize specialized and cooperative production of flexible production systems (GPS's) and introduce them widely in the national economies of the socialist states. And we can already talk about the first results.

The very fact of cooperation by specialists from the two fraternal countries and how efficient it was confirm again the existence of broad opportunities for introducing the latest technical and technological advances into the economy.

A solid base for this has been built in the socialist countries. Each year the production of machine tools with digital programmed control, processing centers, industrial robots, robotized complexes, and mini- and micro-computers increases. Flexible production modules and systems are built on their basis. The Soviet Union, for example, plans to make more than 100,000 industrial robots, 4,000 automatic and semiautomatic lines, and more than 100,000 machine tools with digital programmed control in the next few years. Our country is the leading developer in this area. Specialists from the fraternal countries, which have accumulated considerable experience in developing and building flexible production systems too, are also making a large contribution.

I have had numerous occasions to visit the associations and enterprises in the fraternal countries where the equipment that goes into flexible production systems is developed and manufactured. For one, two years ago our Hungarian comrades demonstrated a first-generation integrated system in one of the shops of the Csepel Machine Tool Plant. This enterprise is now using the Diogon-500 system, built in cooperation with Czech and Bulgarian specialists. It consists of four processing centers with devices for automatic replacement of "satellite-platforms" with parts and an automated storage center.

But even such a modern facility is not the last word in introduction of flexible production systems today. For example, a more intricate production complex is

being turned over for use at the Budapest Reducer Gear and Painting Machine Plant. It will consist of three processing centers, storage areas for tools and instruments, an automatic transportation system, and a computing center. The complex will machine about 90 types of housing parts for industrial reducing gears.

They are taking an equally differentiated approach to the introduction of flexible production facilities in Bulgaria. Under the national program, they are directing their primary efforts to automation, and therefore to introduction of flexible production systems in the metalworking sectors. They use them to make parts of varied size and configuration such as bodies of rotation and housing parts. At the same time preparations are under way to use flexible production facilities in the semifinished part, assembly, welding, and painting shops. The appropriate machines with digital programmed control, computers, robots, and warehouse-transportation equipment are being developed to perform these jobs.

The head enterprises in the republic for this important subject area are the Sofia Metal-Cutting Machine Plant and the Beroye Science-Production Robotics Combine from the city of Stara Zagora. They are accumulating, so to speak, the achievements of other enterprises of the republic which produce high-moment engines and servomotors, highly complex hydraulic equipment needed to produce robots, minicomputers, and many other things which are so necessary to incorporate this modern and efficient output.

Bulgaria is already operating a number of flexible production systems. On of them is at the Combine imeni G. Kostov in the capital. Eight thousand type-sizes of aluminum brushes for electric motors go through complete machining in this system. An innovation of our Bulgarian friends is particularly interesting -- the flexible production system operates on a fully automatic basis. This complex, which processes body of rotation type parts, does all the operations from receiving the semifinished part from the warehouse to turning out the finished output (an axle for a gas-powered cart) without the part being touched by human hand. The system has five modules, four Bulgarian and one joint Soviet-Bulgarian machine tool manufactured at the Moscow Krasnyy Proletariy Plant. It operates an RB-241 robot built at the Beroye Combine. Preliminary calculations show that the innovation is three times better in terms of labor productivity and that it reduces production area by the same factor of three. It increases the shift coefficient of equipment by 2.5 times!

The numbers speak for themselves. In fact, a plant without people is no longer fantasy; it is reality. Among others, in the not-too-distant future the First and Second Moscow Clock Plants will become fully automated production facilities. Such sites are also a kind of testing ground where the latest systems for control of industrial and production processes are put through trials. Their experience will make it possible to move on to broader introduction of "no-human" technologies.

The GDR, which is known for its advances in robot building and for setting up processing centers, already has flexible production systems in use at various enterprises. In their development work our German friends make broad use of experience from the fraternal countries. Specialists of the republic research

center for machine tool building in Karl Marx Stadt are working successfully in this sphere. They maintain close contacts with design organizations in the socialist countries. Cooperation with VUSTE in Czechoslovakia has been especially beneficial.

VUSTE is the Scientific Research Institute of the Technology and Economics of Machine Building. It is located in Prague. Its collective has participated in the development and introduction of equipment for flexible production systems at many Czech plants, including such large ones as Skoda in Pilsen, TOS-Kurzim, KOVOSVIT-Sezimovo, Usti, and others. The equipment installed at each of them takes account of the particular enterprise's specialization, even though it is invested with a common idea and was all built according to a unified design.

Work on the introduction of flexible systems in the republic has now entered a new phase. This can be traced especially vividly at the TOS-Gostivarz enterprise. On the initiative of VUSTE and with participation by its specialists they are building an automated production facility there that consists of 13 primary industrial, auxiliary, and storage sections. These sections will essentially encompass the whole process of machining and assembling parts, ending with receiving the finished output -- grinding machines with digital programmed control!

The VUSTE specialists have set themselves a difficult task. To solve it they outlined building four robotized, integrated sections. Three of them, equipped with the latest machine tools with digital programmed control and built in Czechoslovakia, the GDR, and the USSR as well as other up-to-date equipment, are designed to process parts of various sizes. They are already in operation and have confirmed the developers' prognosis: the quality of the output is excellent. It could not be otherwise -- every process is observed by the vigilant "eye" of the computing center, where they use small computers produced in the republic within the framework of cooperation among the fraternal countries in this important sphere.

I think that these instances show a great deal. The scope of work in the socialist community to automate the processing sectors and put the new systems in use in light and food industry is steadily broadening. This work, of course, requires coordination of all actions. And this was the subject of a businesslike, exhaustive discussion at the international meeting of leading specialists in flexible automated production facilities from the CEMA countries in Prague. Combined efforts will be focused on formulating a unified conception of the flexible production system based on the modular principle of construction and on development of the appropriate CEMA standards for flexible production systems and a number of other questions. A Long-Range Program of Multilateral Cooperation in the development and use of flexible production systems in the economies of the CEMA countries in 1986-1990 and the period until the year 2000 will be worked out.

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AUTOMATED LINES AND AGGREGATED MACHINING SYSTEMS

REASONS FOR SLOW IMPLEMENTATION OF FLEXIBLE PRODUCTION SYSTEMS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 23 Aug 85 p 2

[Article by V. Karzhan, general director of the ENIKmash [Experimental Scientific Research Institute of Forge-Press Machinebuilding] NPO [Scientific Production Association] and A. Kruk, general director of the Production Association for Manufacturing Heavy Mechanical Presses: "How to Come Out on the Fairway: An Integrated Approach to the Introduction of Flexible Systems" (Voronezh)]

[Text] Recently, the abbreviation "FMS" [Flexible Machining Systems] has been rapidly entering the lexicon of specialists. Born by scientific-technological progress, this concept carries a deep meaning related to a new direction in the development of industry. This is why scientists, designers and technologists work intensively on creating flexible machining systems. However, in spite of the obvious benefit, the introduction of FMS in the national economy is proceeding extremely slowly. Why?

There is no single answer to this because the complexity of the problem generates other problems no less complicated. Take, for example, the robotization of forge-press equipment. First, production people encountered a lack of specialists. This is becoming ostensibly better: many vuzes have introduced robot equipment courses. However, there is still no engineering training. Operating people and middle link specialists are needed. Who will train them...?

There is still another obstacle -- lack of production areas and technological unpreparedness for operating automated complexes. As shown in practice, these difficulties are seemingly combined with a very dangerous force -- inertia in thinking. Instead of calling for help in creative thinking, certain managers, frankly speaking, are taking the beaten path.

Let us say that they receive at the plant the ordered complex and ... quickly it is disassembled. The automation facilities are sent to the warehouse while the basic technological equipment (press, shears, rollers) is installed in shops and is used in traditional technology. Nobody seems to take the responsibility for such independent action.

Other managers proceed more simply: they refuse FMS on various pretexts. This year alone the Voronezh Production Association for Manufacturing Forge-Press Equipment imeni M. I. Kalinin received refusals from over 50 enterprises that did not want automatic complexes in the line. They include the Tambov Slide Bearings Plant, the "Tadzhikgidroagregat" Production Association, the Kherson and the Tula combines. At one section of the latter plant, parts from metal coils are stamped in the old way. The use of the automatic complex would have increased labor productivity by several times. This is why the combine plant ordered the equipment. We could start filling the order when suddenly the order from Tula was cancelled. Perhaps, the customer had a complaint with regard to the technical standard of the equipment? Not at all. The reasons were the same: lack of production areas, technological unpreparedness and financing problems.

At first glance, the motives for refusal were convincing. On the other hand, it cannot be evaluated other then there was no desire to keep step with progress. At the June conference of the CPSU Central Committee, it was stressed that there is no time to vacillate. However, plant workers found it much easier to write a refusal of the order rather than persist and fight for their ideas with the All-Union Production Association and the ministry.

It is obvious that most refusals are from plants and associations of the Ministry of Agricultural Machinery. Perhaps, they do not need automatic complexes? Nothing of the kind. Thousands of forge-press equipment stand idle in the sector because of the lack of service workers. Hoping to solve the personnel problem by an influx of working hands is illusory. The only way out is by wide robotization, automation of production and rapid changeover to FMS.

However, the situation is due not to inertia alone. As shown by experience in our country and abroad, without the mutual interest between the customer and producer, it is impossible to count on success. The question should be posed as follows -- introduce the system and obtain a yield from it as soon as possible. In other words, the FMS problem demands a comprehensive solution. Here the experience of the Voronezh Production Association of Heavy Mechanical Presses and that of the Moscow "Avtozil" merits attention.

Even at the initial stage of designing a shop or a section, partners review the entire range of questions. A modern technological process is developed with automated equipment facilities, transportation-warehousing operations, provision of required tools, etc. Lately, the association, using rights of a head organization, took upon itself the duty of furnishing complete sets of manufactured equipment, including machine tools, machines and apparatus manufactured by other enterprises. At present, using the same arrangements modern hot stamping productions are being created in the "Avtogaz" Production Association, at the Taganrog Combine and the Kamyshinsk forge-casting plants. In the same way multiproduce production will be created at the Zaporozhye Motor Building Plant.

What does this mean? The introduction time of flexible productions are reduced considerably. If, previously, it took, say about three years to introduce an automatic hot stamping line, with the new organization now it takes not more than a year. At present, the customer loses no time on all kinds of coordination. Assembled in one place, the set of machines, machine tools and automation facilities passes through the necessary check-outs and is shipped fully ready for operation. The customer is the winner. What about the manufacturer? He has no profit, except moral satisfaction: the collective of the association knows that the equipment manufactured in its shops does not lie in the dust of a warehouse, but operates as intended.

The new order of the interrelationship between the manufacturer and consumer is, in our opinion, only a part of the more general problem. There is still another obstacle in the path of the FMS -- the existing practice of designing new productions when developers use outdated catalogs of equipment and introduce technological processes that cannot be automated. It is also time to discard set norms for areas, building heights and other design parameters that do not conform to the sizes of robot equipment, devices, automatic lines and complexes. As an example of such faulty design, in particular, there is the Kirov "Tsentrokuz" Plant (Voroshilovgrad Oblast), where specialists of the Moscow "GiproNIIMASH" Institute proposed old stamping hammers, while automatic forging complexes are available. In designers' errors, we see one of the reasons why the plant could not overcome design goals in the current five-year plan period.

What is the situation with the introduction of automatic forge-press equipment at the start of the 12th Five-Year Plan period? Orders for it from the Soyuzglavstankoinstrument of the USSR Gosnab were received in July, while production plans for 1986 at the enterprises manufacturing this equipment were already formed in January-February. It is entirely possible that there is a gap between the ordered requirement and the production plan. We were convinced of this many times in our own experience. In our opinion, orders for automatic equipment must be received before the production plan is formed. In the meantime, in connection with the absence of information in the Gossnab, it was necessary to conduct a questionnaire of ministries and departments, which, on our assumptions, needed the latest forge-press equipment. Answers were received from far and wide. Either enterprises or departments do not have information on new equipment, or they still are thinking about what to do. This slowness is fraught with great errors.

There is also an objective reason. Robotized complexes, flexible production modules and sections operate for three shifts to insure the highest output to capital ratio. At times, it is found that at one enterprise the automatic equipment cannot be loaded fully, while using it only a third of the time is too much of a luxury. Can there be a way out?

Professor M. Ignat'yev, manager of system programs for flexible machining systems of the RSFSR Ministry of Higher Institute of Learning suggests the following versions. First, the organization of technological center clusters to serve enterprises of one sector. Second, the creation of regional

cooperating centers to service enterprises belonging to different departments, that change over rapidly after completing one order to another. As applied to the forge-stamping production, such centers must be created along basic technological conversions and be strictly monitored.

Apparently, it is best that the Gossnab organizations place the orders and oblast organizations do the planning. In organizational matters, the priority belongs to Soviets.

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AUTOMATED LINES AND AGGREGATED MACHINING SYSTEMS

LONG PAYBACK PERIOD OF FLEXIBLE PRODUCTION SYSTEMS CONSIDERED

Moscow EKONOMICHESKAYA GAZETA in Russian No 40, Oct 85 p 15

[Article by L. Volchkevich, doctor of technical sciences, chairman of the VSNTO [All-Union Council of Scientific Technological Societies] Committee on Automation and Mechanization of Production Processes: "Are GAP [Flexible Automatic Production] Always Effective?"]

[Text] This is not an idle question since it is clear to everybody today that there are no alternatives to the introduction of FMS, including a flexible production machine and aggregated machining systems (GPS). Therefore, what is very important is how much money will be spent on this and how will they pay for themselves.

It cannot be said that academic and applied science avoids paying attention to FMS. On the contrary, scientific technological literature literally overflows with publications on this subject. Regrettably, a considerable part of them is devoted to general praise of the new direction and to the enumeration of the bright prospects instead of a comprehensive analysis of the real difficulties and ways to overcome them. Sometimes an impression is created that it is sufficient to solve the problem technically, i.e., compose a production system that would "eradicate" manual operations by robots and microprocessors and thus increase the productivity of labor. The rest will take care of itself.

Most frequently numbers are cited on the achieved increase in the productivity of labor given as proof of intensification. However, the indicator of the increase in the productivity of labor as applied to a section or shop -- is an increase in the output of one worker, which may be accompanied by an increase in the cost of production and a reduction in the output-capital ratio and with direct economic losses. How critical should one also be of the numbers of freed workers without answering the question: at what price?

Costs and results

The substantiation of creating GPS only by these indicators contradicts also the officially accepted methods and evaluations of the economic effectiveness of the new technology. If its introduction requires additional capital investments, then production costs and repayment periods on norm schedules must be reduced. One of the most important effectiveness indicators is the improvement in the output-capital ratio.

A GPS was created at one of the Leningrad enterprises for machining parts consisting of 6 multioperational NC machine tools at a cost of 350,000 rubles each. The GPS has a transport-storage subsystem for the products, a set of devices for automatic supply of tools to the machine tools and their change in the tool magazines, a transport subsystem for removing chips and a computer control subsystem. The cost of the GPS is over 6 million rubles.

If the new line is compared to a line with equivalent technological possibilities and flexibility with a group of boring machine tools, it is not difficult to note that the technological arrangements for machining and the structure of the working cycle remained unchanged. The methods and routes of machining, as well as the technological modes are the same.

If there is no progress in technology, the gain in the technical-economic indicators is possible only due to two factors: an increase in productivity and a reduction in the number of workers. But here the productivity of the machine tool equipment is approximately doubled, while the cost is increased 15-fold! Therefore, if only the technological equipment is compared, the output-capital ratio was reduced to 1/7, while if the cost of the equipment for the entire system (the warehousing, the transportation system, the computer by themselves do not produce products), then the output-capital ratio decreased to 1/20-1/25!

GPS on any scale must have not less than 4 to 5 persons for servicing, therefore, with 5 to 6 machine tools in the GPS, the gain in reducing the number of servicing personnel is minimal. It should be taken into account that many kinds of auxiliary work in creating GPS are not automated and are not reduced, but only changed (installation and removal of parts in fixtures, tools in magazines).

To summarize: the saving in live labor, due to a 2-2.5-fold increase in the productivity of the machine tools (on the basis of three working shifts) for a 10-year operating time of GPS, is not greater than 80 to 120 man-years. But the GPS cost of 6 million rubles is an additional reified labor of about 1000 man-years! If added to this are current costs, related to repairs and servicing between repairs, the total balance becomes still more negative.

What does GPS lack?

Only such equipment is considered progressive in which an increase in productivity is greater than the increase in cost. Why then are GPS of today so superhighly expensive? One of the reasons is that each new system is designed individually, while its modules, including technological fixtures, are manufactured or modernized and interconnected under primitive production conditions, at superhigh costs.

In the very near and foreseeable future, specifically technological equipment may become the stumbling block for successful and effective introduction of GPS. It has been calculated that in modern series production, up to 80 percent of special, nonreadjustable equipment is used. It is unprofitable, at each GPS, designed for machining several dozens of product types to have a set of a 100 special equipment units.

The second no less important problem is a considerable increase in the GPS productivity, the expansion of their operating time to 24 hours a day, and in the future, including holidays. For this it is necessary to increase the reliability of all GPS components, especially, of all the technological equipment by an order of magnitude.

Specifically here, where the enumerated and other problems will be solved faster, where the "spread" between an increase in cost and an increase in the GPS productivity is eliminated or reduced to a minimum, will prospects for their mass introduction open up.

It is very important that the experience of mastering GPS become the property of everybody who needs it. In its time, the ENIMS [Experimental Scientific Research Institute of Metal-Cutting Machine Tools] designed two automatic sections controlled by computers, the forerunners of today's GPS. At that time, their pictures and descriptions decorated pages of many publications with promises of multimillion ruble dividends. Nobody remembers these millions; the sections are dismounted, but it is said that priceless experience was accumulated. But what experience and for whom? All data is hidden in service reports of the ENIMS while the main conclusions on whether or not it is necessary to create such systems, have not been made.

Priority goals

Somehow an opinion was created that the GPS should be created primarily for machining by single-spindle multioperational NC machine tools of the "machining center" type. But in fact, this is not true! There are at least three versions of flexible production: mass production with readjustment for other similar products; series production with relatively stable products, where the necessity of frequent readjustments is dictated only by an insufficient output scale; finally, production with an indeterminate constantly, changing product list.

In our opinion, only in the last cast should single-spindle NC machine tool be used without question.

Moreover, there are application where GPS creation provides considerable gain in the quality of products and in the productivity of production equipment in other -- not metal cutting -- operations.

At the "Industrial robots and robotized technological complexes" in exhibit of the USSR VDNKh shows a complex introduced at the "AvtoBAZ" for point welding of cabs, which replaces 8 welders and produces better quality welds. Great potential possibilities open up in creating GPS for thermal treatment, electrical plating, etc., where additional costs and readjustment time are relatively small.

GPS creation primarily for machining, where equipment reliability is minimal while readjustment difficulties are maximal, may turn out to be erroneous.

On what basis then are GPS to be created? What innovations should be incorporated in them primarily?

It would seem that there cannot be two opinions here. Many years of information experience have indicated that the basis of its effectiveness is progressive technology, concentration of operations in time, continuity of their implementation which increases the productivity of labor many times.

Precisely, to this path -- automation on the basis of progressive technology-- are the decrees of the April (1985) Plenum of the CPSU Central Committee and of the June Conference of the CPSU Central Committee pointed on the question of accelerating scientific technological progress.

However, the realistic practice of automating flexible production is such that the majority of GPS being created are based on a long-known technology and single-position equipment with minimal technological potential.

Therefore, all bases exist to assume that the first GPS generation will bring results only at the level of finishing off designs and structures, while on the technical policy level -- identify only the principle on how "it should not be done."

Is the cost not too high?

Managers, engineers and economic service of enterprises should treat the problems of introducing flexible systems and productions especially responsibly in light of the recent decree of the CPSU Central Committee and the USSR Council of Ministers on machinebuilding complexes.

Automation problems at all stages of production, reequipment and modernization on the basis of the broad introduction of new technological processes and systems, mechanization facilities, automation and robotization are on the same level as improvement in economic indicators. A multiple increase in the productivity of labor should be accompanied by an increase in the output-capital ratio.

2291
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AUTOMATED LINES AND AGGREGATED MACHINING SYSTEMS

UDC 621.941.2

ROBOTICIZED MACHINING CELL FEATURES UNUSUAL CONTROL SYSTEM

Kiev TEKHNOLOGIYA I ORGANIZATSIYA PROIZVODSTVA in Russian No 3, July-Sept 85 pp 12-13

[Article by V.F. Osipenko, candidate of technical sciences: "Mechanization and Automation of Industry: Roboticized Technological Complex for Production of Shafts"]

[Text] An important precondition for broad introduction of personnel-free blank-working technology is finding some way to use the available equipment in machine-tooling plants in flexible automated systems.

The Voroshilovgrad Machine-Building Institute has designed, built and tested a robotic technological complex for machine working graduated shafts of average diameter. The complex consists of an S1E61PMFZ threading lathe (1) (see figure), an ATPr-2M12S revolving NC lathe (6) and a 2R135F2 vertical drilling lathe (3). These machines provide fully mechanized machining of shafts of more than 30 types of shafts used to manufacture diesel locomotives. The complex is loaded and unloaded by a Universal-5 (5) lathe manipulator.

Piece blanks in the form of preliminarily cut rolling stock is manually loaded by the operator into the corresponding cells of a carousel magazine (8). In a sequence determined by the machine-working technological process and the production program, the manipulator (5) takes a blank from a cell of the magazine (8) and feeds it into the thread cutter or other machine where it is automatically held in place and worked. The same manipulator takes the blank from one machine to the other and returns it to the magazine after it has been completely machined.

The robotic complex makes it possible for the machines to work in parallel. This considerably reduces the length of time that they are machined and increases the complex's output. Therefore, with a part-machining cycle lasting 10.3-12.6 minutes, there are only 3.8-4.7 minutes between the working of two consecutive blanks.

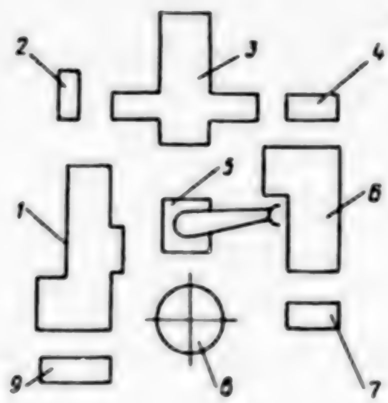
In the creation of this robotic complex, much effort was spent on developing a control system. Known systems control the work of all of the complex's elements through the use of a central computer with a corresponding program.

Each element of the complex has the same layout with the computer and the same control language.

This complex includes machines with various control schemes. Thus, the thread-cutting lathe is controlled by the FS-2T (2) according to a program recorded on a 32 mm magnetic tape while the revolving lathe is governed by a program written in BTsK-5 code by a Salyut-2D (7). The program for the vertical drill-lathe is carried by a 25.4 mm tape on which the program is written in ISO-7 bit code. And finally, the manipulator itself is controlled with the help of a command apparatus with a jack apparatus.

Machines with various control systems were specially chosen for study of the possibilities for uniting them in a single robotic complex.

As the studies showed, microprograms were found to be the best means of controlling such a complex. Every element of the complex is governed by its own program from its own controlling device. The manipulator gives the command to input or remove a program. The use of this system has demonstrated its high performance and durability. The given control system can be easily manufactured inexpensively at any machine-building plant with NC machines and lathe manipulators.



Robotic technological complex for machining shafts: 1. SlE61PMFZ thread-cutting lathe; 2. FS-2T control device; 3. 2R135F2 vertical drill-lathe; 4. Coordinate 70-3 control device; 5. Universal-5 lathe manipulator; 6. ATPr2M12S revolving lathe; 7. Salyut-2D control device; 8. magazine; 9. work control panel.

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AUTOMATED LINES AND AGGREGATED MACHINING SYSTEMS

BRIEFS

AUTOMATION EQUIPMENT EYED--The CEMA countries are jointly planning to undertake construction and mass distribution of flexible automated production systems, robot engineering, automated design systems, and the like based on advances in electronics. The USSR, for example, plans in the upcoming five-year plan to manufacture about 2,000 flexible automated production systems (including fully automated sections, shops, and plants), more than 100,000 industrial robots, and up to 3,000 automated design systems. Considering the decisive importance of machine building to support technical progress on all fronts of the national economy, the CEMA members are developing this sector at a faster pace. Thus, while the aggregate industrial production of the fraternal countries doubled between 1970 and 1983, their machine building output almost tripled. The share of machine building in the industrial production of the European CEMA countries has reached an average of one-third and continues to rise. There are more than 250 multilateral contracts and agreements on specialization and collaboration alone today. Mutual export of machine building products of the fraternal countries is growing rapidly, and has passed 50 billion transfer rubles. In just the last three years it has risen about 20 percent, while the mutual exchange of specialized output has gone up some 45 percent. The proportion of specialization in the total volume of machine building output of the CEMA countries has reached almost 40 percent. [Text] [Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV in Russian No 2, Feb 85 p 46] 11176

FLEXIBLE MODULE IN ODESSA--Odessa, 12 [Aug]--(TASS)--The flexible production module built by specialists at the Odessa Machine Tool Building Association and the Experimental Scientific Research Institute of Metal-Cutting Machines can machine intricate parts quickly and with high precision. After completing manufacture of the first industrial model of this equipment, the enterprise fulfilled its five-year program for updating output. The adjustable module is equipped with a system for automatic replacement of tool magazines and unfinished workpieces. Whereas before only two operations could be performed at one time in the processing center, in one pass now they produce a part that is finished and ready for assembly. After completing its assignment, the automaton switches to making the next batch of parts without stopping. The computer program must be changed to switch it to producing articles of a new type-size. One such module replaces almost 50 lathe operators of various specializations. The designers composed it from discrete units, which makes it simpler to outfit different variations of controlled, unmanned systems. [Text] [Kishinev SOVETSKAYA MOLDAVIYA in Russian 13 Aug 85 p 1] 11176

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ROBOTICS

LENINGRAD ROBOTICS INSTITUTE HEADS CEMA GROUP

Moscow PRAVDA in Russian 4 Nov 85 p 4

[Article by L. Chausov, correspondent (Leningrad and Moscow)]

[Abstract] The article reports on cooperation of socialist countries in development of industrial robots and the leading role that is being taken by Soviet organizations. It is said that a comprehensive conception of the advancement of robotics was worked out in the USSR, with the main applied work being pursued in the northwestern part of the country. The robotics program has been adopted by other countries of the Council for Mutual Economic Assistance (SEV) as a unified technological program for joint work, with specialization of scientific and industrial organizations of the participating countries.

A leading role in the program is being taken by the Central Scientific Research, Design, and Experimental Institute of Robotics and Technical Cybernetics (TSNII RTK), which has been created at the Leningrad Polytechnical Institute. Construction of buildings for this new robotics institute is under way at a site which is a few minutes drive from the polytechnical institute. The article records comments of the robotics institute's director, Doctor of Technical Sciences Ye. Yurevich, who is also chairman of the Council of Chief Designers for Industrial Robotics of the Member Countries of SEV. He explained that the basis for the international cooperation is the 1982 General Agreement on Multilateral Cooperation in the Development and Organization of Specialized and Shared Production of Industrial Robots. Under it, the council of chief designers has undertaken the drafting of a unified concept for advancement of robotics in socialist countries. The concept calls for comprehensive standardization of all robot parameters, including their mechanical part, control systems, and software, based on the principle of modular construction. The council has drawn up a priority list of robots and their components, identifying 165 types of products, which are said to constitute about two-thirds of all types of robots that are expected to be needed by 1995. The program of comprehensive standardization of robotics equipment which is to be gradually implemented through the period to 1990 includes 22 standards, four of which have already been confirmed.

It is reported that an international scientific-technical association called "Robot" was established in the spring of 1985, with the USSR and Czechoslovakia as participants. Its general director is Yu. Kozyrev. A group of Soviet specialists reportedly left not long ago for Presov in Czechoslovakia, where the "brain center" of the new organization is located.

Commenting on specific results of cooperation in robotics, the article notes that a robot called RB-112 was developed and is being manufactured in Bulgaria. It is intended for servicing machine-tool aggregates, including Soviet-built ones. With the collaboration of the Ukrainian Academy of Sciences' Institute of Electric Welding imeni Paton, Bulgarian specialists also developed a robot with an original control system for arc welding. Soviet and East German specialists have combined a lathe and a robot into a highly-productive robotics complex. Another development, by Soviet and Czechoslovak specialists, is the UM-160 robot for servicing groups of metal-cutting machines.

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CSO: 1823/068

ROBOTICS

ROBOT DEVELOPMENTS REVIEWED

Moscow ZHURNALIST in Russian No 10, Oct 85 pp 27-29

[Article by Yuriy Samoylov, candidate of technical sciences: "What Will Robots Bring US?"]

[Excerpts] The first industrial robots operated according to a rigid given program for which they were named programed robots. In spite of forecasts by some specialists only several years ago they have not yielded their place to more perfect adaptive robots equipped with "sensing" organs. At present, plants in the entire world, in most cases precisely these devices are used and they are controlled by microcomputers. Primarily, they are used in machine-building, especially, in the automobile sector. Basically, they are used in die forging and machining and moving parts. Gradually, the number of robots that can assemble, weld, paint and do precision casting increases.

An individual robot itself cannot produce the effect which can be obtained from it in flexible automated production. Flexible systems consist of NC machine tools that fulfill many operations with automatic changes of cutting tools, robots-loaders and carts which transport materials; the machine tools are combined into centers or sections for machining parts. All components of the flexible system are tied together by a single electronic control. Such systems make it possible to change over from the output of one kind of a product to another one in several hours or even minutes.

There is another reason for the necessity of overcoming colossal difficulties in designing and introducing flexible systems. Conveyors and automatic lines used in plants are designed for the mass output of products in huge lots. At the same time, in modern life, the process of article renovation has accelerated sharply. New, more modern models replace outdated ones. In this situation, the importance of production with small series and individual products rises sharply. At present, three quarters of all machined parts are manufactured in lots of 50 pieces and less. These, for example, are many parts for planes, ships and large computers. To make such parts using traditional methods is too expensive, while to create a specialized automatic line for them is simply senseless. Flexible systems, however, make it possible to manufacture in small series and even singles, obtaining thereby efficiency comparable to that achieved on automatic assembly lines that manufacture millions of the same products.

So far, our hopes for a sharp increase in the productivity of labor, and the creation of premises for reducing the still considerably share of heavy physical and manual labor, are tied to the fulfillment of the general union program for flexible automatic production and robot equipment. The April Plenum of the CPSU Central Committee in 1985, which posed the problem of accelerated changeover of the national economy to the rails of intensification, as did the June conference of the party Central Commitee is also aimed at this. The system for training proper specialists is being developed. Recently, measures were defined in the Politburo of the CPSU Central Committee on the computer literacy of secondary school students and the wide use of computers in the learning process. The park of robots whose mass production began in the current five-year plan period is rapidly increasing in the country. In 1984, 13,700 were produced which is 25 percent more than in 1983. In 1985, it is planned to manufacture about 15,000 robots -- almost triple that of the entire preceding five-year plan period. A number of welding, electromechanical, modular and other robots was created. The International "Robot Complexes-85" Exhibition at Sokolniki in Moscow in February this year showed that domestic robot equipment is developing basically according to world trends. At the same time, the reliability of our robots as a mass still lags considerably behind the level reached abroad. Moreover, some types of domestic robots are still not sufficiently adroit. In a number of operations, they are not only behind special automatic machines, but also people.

Therefore, it is still necessary to work seriously on raising the technical standard of domestic robot equipment. Here, obviously, mass information organs must play a large role. However, according to my observations journalists do not work hard enough to uncover shortcomings that retard progress in this area, while describing the much desired beautiful projects of the remote future.

Yes, without doubt, further development of computers will lead to the creation of robots with artificial intelligence. Robots will penetrate all areas of human activity and will become such customary household components as automobiles, TVs and tape recorders. They will be able to communicate not only with man, but also with each other, forming groups for joint work. However, the creation of such devices is still far away. For a long time, the robots will basically require human participation.

I admit that the guilt in sensationalism is not so much due to journalists as to editors who demand attractive material. In the final analysis, however, the desired is sometimes expressed as actual and a false concept of the possibilities of modern robots is created in the readers.

Article after article makes statements, for example, such as, robots "can do everything or almost everything." Up to this time, false forecasts are being printed that already in 1985 the basic part of the robot park will consist of so-called adaptive, sensitized devices. But 1985 arrived a long time ago yet nothing of the kind occurred. Such robots make up only several percent of their total number. Needless to say, journalists do not think

up such information themselves, but it seems that it would be useful to make a more critical interpretation of the obtained information, especially in such a rapidly developing area as robot equipment.

The main thing, of course, is to change the sensational publicity approach of the robot theme to a realistic, business-like one, in order to facilitate actively the acceleration of the new equipment. This problem is still unsolved on a countrywide scale. In my opinion, it is very important to maintain the initial successes. Production is robotized at "Krasnyyproletariy" and ZIL plants, at the watch plants and at a number of other enterprises. It would be desirable to see greater participation in the development of economic levers which would stimulate the use of robot equipment complexes.

Modern equipment must be created by modern methods. Organization and planning of its production should be presented in print in an interesting manner. The development of robot equipment in socialist countries is facilitated by the constantly expanding cooperation and organization with the CEMA framework of specialized and cooperative production of robot equipment. The general agreement concluded in 1982 by the CEMA countries in the area of robot equipment specifies standardization of units and parts, as well as the use of the modular principle. Combining modules, these standard components, makes it possible to assemble robots for the most varied purposes. The general agreement combines a number of industrial sector agreements according to which individual components are developed jointly for industrial robots (types of drives, control systems), as well as a certain type of robots. A Council of Chief Designers functions within the CEMA framework. It developed a program for scientific technological cooperation adopted by corresponding CEMA organs. A number of other programs is also being implemented on creating, for example, electromechanical robots with technical "vision," other sensing means, etc.

In 1986-1990, the volume of mutual deliveries of robots between the CEMA countries will increase many times. It is planned to create special robots for machining, metals, casting, forging, assembling, as well as for use in nonproductive areas.

The implementation of such long-term and broad-scale programs is possible only in a socialist society without the unemployment unavoidable under capitalism.

By the way, journalists, I think, are not always right when they tie the necessity of accelerating technical progress mainly to the case that equipment must make up for the shortage of people. This is important, but not the main aspect of the matter.

Accelerated improvement in production, particularly its robotization, is a question of the historical fate of socialism. The party speaks quite definitely about this. Here, as in many other things, the time has come to rebuild the consciousness, the propaganda work and the style of activity.

2291
CSO: 1823/059

ROBOTICS

UDC 621.856.8:629.113.002

ENTERPRISES DEVELOP, INSTALL OWN ROBOT SYSTEMS

Moscow AVTOMOBILNAYA PROMYSHLENNOST in Russian No 9, Sep 85 pp 34-37

[Article by V. F. Rzhevskiy and A. Z. Brodskiy, NIIAvtoprom: "Industrial Robots and Robotized Technological Complexes"]

[Text] One of the most important directions of technology development in automobile building is the automation of production processes whose new qualitative stage is becoming the robotization of production.

Such work is being done. For example, in 1981-1984 alone, enterprises in the sector introduced over 1000 robots and manipulators with a considerable part of them manufactured by plants themselves.

Thus, the VAZ [Volga Automobile Plant] mastered the production of robots and manufactured over 3000 MP-95 robots with a lifting power of up to 0.3kg, began the output of an MP-11 modular robot-manipulator with a lifting capacity of up to 1kg, which, as compared to the MP-95 robot, has a greater lifting capacity and can have a single arm or double arms; capacities are being created for series production of welding robots with a lifting capacity of up to 100kg which will be introduced for the point contact welding of bodies, cabs and units of the VAZ, ZAZ, ZIL, GAZ, MAZ, KrAZ and other automobiles. The ZAZ Plant manufactures in series the BRIG-10 robot with a lifting capacity of up to 10kg. It is used successfully in creating robot equipment complexes in various production associations, for example, complexes for hardening TVCh [High Frequency Current] ball pins and for turning bumper pipes. Because of such robots, the plant personnel designed and began manufacturing and debugging a robotized automatic line for making caps for levers of the transmission gearbox.

Thus, the trend toward increasing the output of robots is obvious. However, the output volume by itself does not have a significant economic effect on the problem of the automation of production: a single robot frees not more than 0.6 to 1.5 production workers. Therefore, the sector is now giving its basic attention to using robots in robot equipment complexes and robotized lines where such an effect is maximal.

For example, the VAZ created a hot die forging section for synchronizer rings consisting of six hot die forging screw presses, each equipped with two MP-95 robots (Fig. 1). One of the robots places the heated ring intermediate product into the die and simultaneously lubricates the upper half of the latter; the second robot removes the finished forging and places it in an oriented position into two ring magazine-storage. The section is serviced by two operators (workers), while previously six stamp operators worked here.

Specifications for model MP-9S robot

Lifting capacity, kg	up to 1
Coordinate system	cylindrical
Number of programed degrees of motion	3
Horizontal movement of arm:	
stroke, mm	150
speed, mm/sec	300
Vertical movement of arm:	
stroke, mm	30
speed, mm/sec	100
Rotation of arm with respect to vertical axis by angle, degrees	120
Positioning precision, mm	± 0.2
Dimensions, mm	488 x 212 x 270
Weight, kg	70

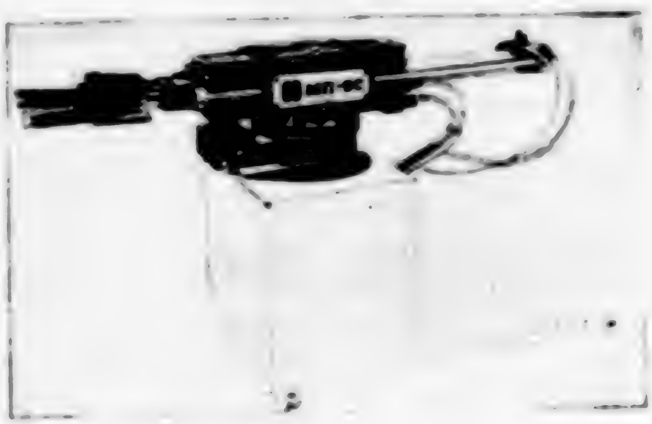

Fig. 1. Model MP-9S robot

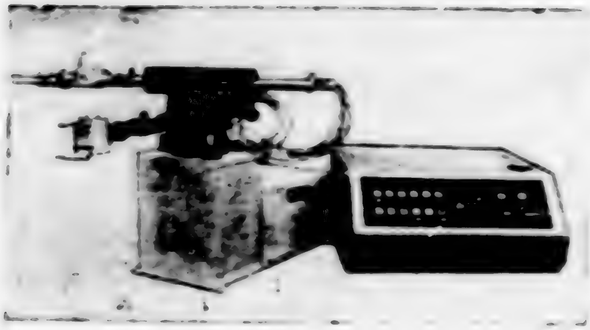

Fig. 2. Model MP-11 two-arm robot

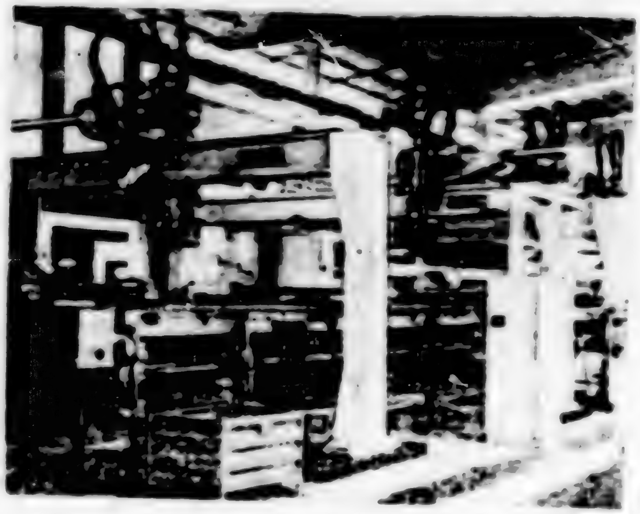

Fig. 3. Type "Pirin" (NRB) two-arm portal robot

In sections for painting assemblies of engines, rear axles, cylinder blocks, rear and front axles, transmission gearboxes and hydraulic actuators, the work is done by RB-211 industrial robots (previously done manually by pneumatic sprayers). Robots with a lifting capacity of up to 15kg are equipped with contour control systems. Programing is done by the manual movement of the sprayer along the required contour in the training mode. The control

system memory holds 75 programs designed for 15 minutes of operation. The robot manipulator has three transportation and three orientation degrees of mobility for moving and orienting the sprayer.

In painting sections for engines assembled with rear and front axles, as well as cylinder blocks, manipulators are located on both sides of a load-carrying and pushing conveyor in special chambers, while in other sections -- only on one side. To paint an article from two sides the conveyor is equipped with a mechanism for turning a hanger, which, entering the painting zone, is rotated smoothly 180° around a vertical axis.

The painting program for each item is selected by a recognition device (of the ZIL design) which makes it possible to process data from 12 sensors and determine up to 15 types of items (programs).

Here, a robot equipment section for assembly and welding a door detent is also in operation. It includes an MP-9S industrial robot and a model MTP-150 welding machine. The robot executes transport, orienting and assembly operations. An ETsPU-6030 electronic cyclic system operates the complex. The robot manipulator is equipped with a rotation device and a "pincer" type grip.

The robot carries and places the first part of the detent into the welding fixture and turns it 180° when placing the second part. After that, it issues an instruction for switching in the welding machine. The finished item is removed by a pneumatic pusher. The operating time of the section is 7 seconds, the welding time and time for removing the item from the welding fixture is 1.2 second. The number of parts in the vibration bin is 400 to 450 pieces.

Robots and manipulators are also introduced in the gasoline tank welding line, making it possible to free 12 production workers who did monotonous operations, replacing them with four operators.

The robot equipment line for cold die forging retainers is in operation at the GPZ-15 (Volzhsk). It consists of two model KD-2326 40 kilonewton presses, two type UXBZ-01.03 bins, loading and orienting devices and a pneumatic transportation tray.

Intermediate products oriented in the vibration bin are moved by a doubled MP-9S manipulator into the die of the first press for "gaging and stretching" the retainer. Gaged retainers are carried by the manipulator to the vibration bin of the second press for the "bottom blanking" operation. The manipulator also places oriented intermediate products in the die zone and, on completion of the operation, the retainer is blown off into the packing by a pneumatic blower.

The introduction of the technological line with manipulators made it possible to utilize the equipment more fully, increase its productivity, free two basic workers and stabilize the quality of the output.

At the Propeller Shaft Plant imeni 25th party congress (Kherson), a section of two sheet-forging presses and MP-9S and MP-11 (Fig. 2) robots was created. The robots load preoriented intermediate products in vibration bins into the die and remove forged parts.

Specifications for two-armed MP-11 robot

Maximum lifting capacity total/arm, kg	1/0.5
Degrees of mobility	6
Positioning precision, mm	±0.05
System of coordinates	cylindrical
Arm movement:	
advance, mm	0-200
lift, mm	0-65
rotate, degree	0-180
Maximum time, seconds:	
advance and retract	0-6
lift and lower	0.5
rotate	0.85
Size, mm	990 x 260 x 435
Weight, kg	75

A robot equipment complex for casting cast iron cylinder sleeves for engines in faced metal molds with a vertical parting plane was introduced by the NIILTavtoprom at the Kostroma "Motordetal" Plant. It does the following in the automatic mode: heats the metal mold equipment, pressurizes the facing coating from a sand-tar mixture in the half-mold and central cores, pours cast iron into the mold, cools castings in the mold, extracts them from the mold, cleans the half-molds and cores of the remainders of the facing, cools the mold to working temperature, pressurizes the pattern plate and applies the separating composition to it. Special features of the complex are: uses central metal cores; simultaneous pressurizing of the facing coating in the half-mold and metal cores with one sand-blowing head; uses the manipulator for taking castings off the metal cores; cleans the molds of residues of the facing coating by mechanical shearing; regulates water cooling of fixtures and its heating by built-in electric heaters.

The KamAZ Engine Plant has a complex of automatic lines for machining shafts which includes over 100 Bulgarian two-arm portal "Pirin" manipulators (Fig. 3). They load intermediate products into the working zone of a machine tool, remove machine parts and place them on interoperational transport.

Specifications of type "Pirin" portal two-arm manipulator

Lifting capacity of each arm, kg at speeds:	
maximum	30
reduce	40
Arm stroke, mm	350, 500, 600
Rotation of grips, degree	180
Speed of cart, m/sec	0.-0.6

Size of parts, mm:	
central (diameter x length)	up to 120 x 1000
chuck (diameter)	up to 250
Size, mm	800 x 1400 x 3700
Weight, kg	2000

The list of robot applications in various operations could be continued; however, from what already has been said, it is clear that the plants in the sector have already accumulated sufficient experience. In particular, it shows that a programable robot is not always necessary and not everywhere to automate production. Moreover, the introduction of special manipulators confirms the effectiveness of these simple and inexpensive devices created by their own forces. Thus, for example, the GAZ uses successfully high speed manipulators for loading presses; the AZLK has three lines for forging average size parts which contain 20 special automatic manipulators, etc. The second conclusion produced by experience: at the present stage of robotization, the basic principle for creating robotized complexes must be one of modular design based on typical solutions useful for multiple reproduction. It makes it possible to avoid changes in individual technical solutions which had not passed through sufficient experimental checks and, therefore, required design corrections in operation. An example of this is a robotized forging module created at the AZLK on the basis of series manufactured MP-9S manipulators. It can be used in automatic sheet presswork complexes and lines.

The module (Fig. 4) consists of press 1, two model MP-9S manipulators, 3 (loader and unloader), a type ETsPU-6030 control device 6, rotary platforms 2 and 5 and plate 4 under the press. Manipulators, located on the sides of the press and attached to its table, are regulated in height and can be moved to the sides to avoid bypassing the guiding columns of the die, and thus makes it possible to provide an operating cycle which does not exceed the time cycle of two-arm type MP-11 manipulators. The reduction in the number of degrees of mobility required for the module makes it possible to use only one ETsPU-6030 for control; this simplifies the joint operation of the manipulators, whose movement sequence is assigned by one program and does not require mutual interrogations. The number of control and interrogation circuits in the ETsPU is sufficient not only to move two manipulators and a press, but also to control the additional equipment of the module -- a feeder for loading intermediate products or the interoperational transporter. The control and interrogation circuits are connected to corresponding circuits of the actuating and informational components of the module through an additional switching device. Its use provides flexible distribution of the ETsPU control channels and the necessary combination in time of various actuating devices of the module.

As mentioned before, wide utilization of industrial robots is a continuation of the course on comprehensive automation on a new qualitative basis. It is proposed to use robots in the sector primarily for automating labor-intensive technological operations. In casting --it is pressure die and metal mold casting; debur, straighten and fettle castings weighing up to 15kg, pack cores; in thermal treatment-harden TVCh parts of the core type, ball pins,

etc.; place and remove parts from hot trays; in hot die forging -- shear seams and straighten intermediate products; automate KGShP [Hot Die Forging Crankshaft Press] and GKM [Horizontal Forging Machine] ; in cold extrusion -- load and unload presses; in sheet metal stamping -- load and unload presses in the second and following operations; in welding -- point and arc weld bodies and cabs of automobiles and their units; in assembly -- feed and setup units and parts, assemble electric apparatus units, carburators, gasoline tanks, etc.; in painting -- paint bodies and cabs of automobiles, buses, apply mastics; in the bearing industry -- stamp retainers, load hot trays, place bearings in packing, check and assemble large size bearings, etc.

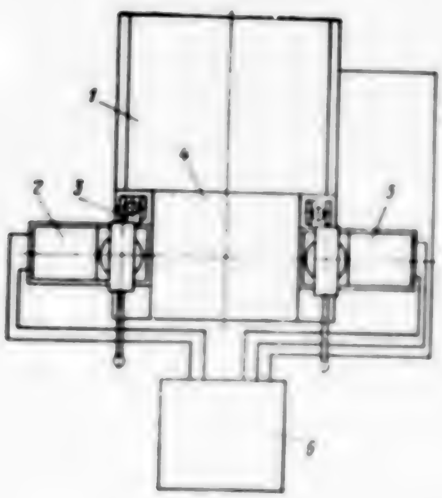

Fig. 4. Arrangement of robotized module.

The introduction of robot equipment complexes in existing production facilities carries with it qualitative, economic, social and technical changes. Economic factors that justify the introduction of robot equipment are related to the increase in labor costs, its limited resources, as well as the trend in the relative reduction cost of automation systems and facilities and an increase in their functional possibilities. The main social factor is that robots free a man from doing tiring, monotonous and heavy work, increase his productivity of labor and reduce the level of scrap.

We will note that the speed of a robot and a man are frequently compared by the maximum speed of work. This comparison cannot be considered rightful: even if a man is capable of doing a certain operation faster than a robot, it is difficult for him to maintain the maximum rate during the entire shift.

while the operating speed of the robot remains constant. Furthermore, unlike a worker who is capable of welding, for example, only 30 percent of the working time, the welding robot is utilized productively 90 percent of that time.

The introduction of industrial robots leads to the redistribution of industrial production personnel because now new trades such as programer and operator become necessary. True, in such production facilities as welding production personnel is still necessary; however, the nature of labor changes. Thus, the welder becomes an operator who services the robot and the welding equipment. He assigns the operating mode to the robot; the welding voltage and current values, direction, starting and finishing times; in the programing process he trains the robot in the sequence of action for changing from one operation to another; he checks the technological process and the quality of welding, providing for the operation of all system links. However, it should not be forgotten that replacing a man by a robot in a process designed for the output of outdated products, using outdated technology will hardly improve the situation.

A promising direction in the development and application of industrial robots is being pursued taking into account accumulated experience in automating production in automobile building, as well as in other sectors of industry with robotization programs implemented by assigning the robots to specific production facilities and work positions, i.e., considering them as the simplest devices (manipulators, mechanical arms, gripper and roller feeds in presses, automatic loading devices in machine tools and automatic lines, etc.), as well as reprogramable robots. All this makes it possible to increase the productivity of labor 1.5 to 2-fold on the average; the shift coefficient of equipment -- 1.5 to 1.8-fold; as well as to improve the smoothness and general standard of production. The use of robots opens up prospects of new in principle technological processes not related to the limitations imposed by direct human participation. Such results, naturally, are obtained only when the use of robots is substantiated technically, socially and economically; robotization of production is based on the group introduction of robots and manipulators taking into account the comprehensive automation of production processes; special subdivisions are created to service and repair manipulators, robots and robot equipment complexes.

2291
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ROBOTICS

APPLICATIONS, CONTROL SYSTEMS OF NEXT GENERATION ROBOTS

Moscow PRAVDA in Russian 4 Nov 85 p 4

[Article by L. Chausov (Special Correspondent of PRAVDA), Leningrad-Moscow: "Robot Serves Man"]

[Text] Robots already for a long time ceased to be the subject of fantasy writers. They are now established solidly in production.

Today, we speak of creating and applying new in principle equipment for the reproduction of mechanical functions similar to those done by the hands of man...

By the wide introduction of industrial robots in the national economy, socialist governments already obtain palpable advantages: productivity of labor increases noticeably and the quality of the output is higher. Robots perform physically difficult and monotonous operations and labor safety is being improved. Moreover, robot equipment is applicable also where man could not function at all.

There is no doubt that it is necessary to solve problems of creating industrial robots comprehensively according to a single coordinated concept in various countries and determine the areas of their application especially advantages gained from the technical-economic viewpoint.

The problem is to introduce this "smart" equipment with a high degree of standardization on the basis of coordinated standards. It is proposed to design the innovations on the modular principle. It presents great possibilities for universal use: a series of various useful machines can be assembled from standard units, so called modules, literally, as from parts of a child's construction set.

It is not by chance that the scientific technological cooperation plans for 1986-1990 of fraternal governments now being prepared, specify the appearance of new robot types for industry. It will become possible to robotize basic machinebuilding technologies -- casting, forging, machining metals, welding, painting and assembling. It will be possible also to provide the necessary equipment for nonmachinebuilding sectors.

Along the line of international specialization and cooperation it remains to "raise" a new generation of adaptive robots which, in the future, will be used widely to create flexible production systems. By the way, according to forecasts of scientists, about 30 percent of all industrial robots for the period up to 1990 will be introduced in the area of flexible automation.

The target concept of scientific technological development of robot equipment was developed in the Soviet Union and finished off in the northwestern region. It spread to the entire country. Later, it was also adopted by other CEMA member countries as a single scientific technological platform for joint work and specialization in scientific and production collectives of fraternal countries. A Central Scientific Research and Experimental Design Institute of Robot Equipment and Technical Cybernetics (TsNIIRTK) was created at the Leningrad Institute imeni M. I. Kalinin.

I was told at the institute that the international cooperation is very fruitful and was given numerous examples of its effectiveness.

Thus, an RB-112 robot was created and tested in Bulgaria; it was designed to service unit-head machine tools, including those made in the USSR. Jointly, with their colleagues from the Electric Welding Institute imeni Ye. O. Paton of UkSSR Academy of Sciences, Bulgarian friends also developed a robot with an original control system for arc welding. With the use of a turning lathe and one of the robot models, specialists of the USSR and the GDR built jointly a high productivity robot equipment complex. The friendly efforts of USSR and ChSSR engineers and technicians produced the UM-160 industrial robot for servicing a group of metal-cutting machine tools.

...After a several minute automobile ride from the institute, we are on the territory of the TsNII TRK. Construction is going on here and buildings are rising.

After standing for a while at the foot of a 70-meter tower made of reinforced concrete, where the monitoring-testing station is located, we entered the building. Laboratories, technical offices, scientific study auditoriums... Specific cooperation between specialists for the creation of new models of robot is coordinated within these walls and is being accelerated.

We get acquainted with Ye. Yurevich, director of the institute, Chairman of the Council of Chief Designers of Industrial Robot Equipment of CEMA, doctor of technical sciences. The scientist informed me that the qualitative new stage of interaction was opened up by the general agreement concluded in 1982 on multisided cooperation in developing and organizing the specialized production of industrial robots. It combines a number of industrial agreements on cooperation between fraternal countries in this area.

The Council of Chief Designers was created to carry it out by undertaking to develop a single concept of robot equipment in the fraternal countries.

"The foundation of this concept is the idea of comprehensive standardization," continued the general designer. "This idea includes all parameters of the robot: the mechanical part, control systems and software. The main principle is the specifically modular design. We took into account and are applying the experience of the successful utilization of modular design in creating NC machine tools and computers."

An important result of the council's activity is the determination of a priority list of robots and of their components. This list already contains 165 items which is about two-thirds of all robot types required by 1995. The problem of creating the remaining type will be solved by joint efforts. It will also be possible to clarify which of the robots and their components are duplicated without substantiation in various countries and coordinate which of the problems must be solved by the international division of labor.

A program is being implemented gradually of the comprehensive standardization of robot equipment calculated for up to 1990. It includes 22 standards, four of which have already been approved.

Along with the increase in the product list, a sharp increase in their technical standard becomes of special importance , primarily -- reliability. The problem is posed as follows: essentially it is necessary to expand the types of electromechanical robots, "sensing" means, including -- technical vision systems.

The CEMA countries are giving a great amount of attention to the output of components for industrial robots (drives, control devices, etc.) and the organization of their mutual exchange. Collaboration in the area of specialized and cooperative production is increasing rapidly: it is planned to increase mutual deliveries of robots and robot equipment complexes in the coming five years several times as compared to the current five-year period. Of course, the qualitative parameters of the equipment will also improve.

The requirements of robot equipment of CEMA countries increase every year. This is why the desire for cooperation increases constantly and why new forms of collaboration appear every day.

Thus, in spring of 1985, the "Robot" International Scientific Research Association (USSR-ChSSR) was established.I recently met Yu. Kozyrev, its general director, in Moscow before a group of our specialists left for Preshov in the ChSSR, where the "brain center" of the new organization, whose activity principle is cost accounting,is located.

"The work on 'Robots' is only developing and I would not want to anticipate events," he said, "in fact, it is not always simple to start a new thing. It is still necessary to overcome difficulties and a lack of coordination. Take for example, the preparation of drawings whose practice is different in each country; we found that even this requires standardization. I will only note that one of our most immediate goals is to create robotized technological complexes, accelerate the work on them over the entire chain -- from drawing to metal."

We wish success to the "Robot" Association. We believe that its international collective will do everything necessary to make the collaboration of fraternal countries mutually beneficial in order that the "integration of an idea" will become still more fruitful.

Robot equipment is one of the priority directions now being created within the CEMA comprehensive program of scientific technological progress for 15 to 20 years. This fact is fairly eloquent in itself. It shows that socialist countries are ready today and in the future to apply their joint efforts to make robots serve people reliably.

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PROCESS CONTROLS AND AUTOMATION TECHNOLOGY

OVERVIEW OF CONTROL SYSTEMS FOR FLEXIBLE PRODUCTION TECHNOLOGY

Moscow NOVOYE V ZHIZNI, NAUKE, TEKHNIKE: SERIYA RADIOELEKTRONIKA I SVYAZ in Russian No 9, Sep 85 pp 1-5, 22-25

[Table of contents, annotation, introduction and portion of book by B.M. Mikhaylov, V.Ya.Neroda, M.N. Kuznetsov: "Flexible Automated Production"]

[Excerpts] Table of Contents

Annotation

The brochure describes a new form of production organization, flexible production systems that make wide use of computer technology. Variants of such systems are discussed along with their practical realization and the production efficiency that they can achieve. Properties of the FMS control system are analyzed.

The brochure is intended for reading by engineers, technicians, teachers and students.

Introduction

One of the chief conditions for technical progress at this time is constant renewal of finished production and the appearance of articles with new technical and economic indicators. Each year, the design of machinery and equipment is becoming increasingly complex and technologically advanced while their service life is growing shorter. Modern design thought is continuously providing society with a mass of new technical solutions. The service life of

a light automobile is 5-10 years. A contemporary lathe has a service life of 4-5 years while many consumer goods last 2-3 years. Each year, new models of televisions, tape recorders and other radiotechnological articles are appearing on store shelves. The manufacture of complicated and rapidly changing equipment involves great costs and expenditures for the preparation and start-up of production.

The creation of modern devices such as computer complexes and data-processing and communication systems is possible only with the participation not only of different factories but also of a series of industries and even cooperation on an international level.

Similar work is being done under large-scale programs that are both designing articles and doing all of the technological preparation, construction, assembly work and organization of series production. With the participation of various factories, all of this work should be done within a short period of time and at the right moment and this requires a high degree of organization. It is obvious that the assimilation of new items will take place at the plants that have already turned out similar products.

For the time being, the modern machine-building technology and the equipment supplied to factories is basically incapable of trouble-free and quick adoption to new production. The basic cause of this complication lies in the fact that a considerable portion of the equipment may turn out to be useless for the manufacture of new items.

The need to organize large-lot production has led to the development and provision of high-speed specialized equipment, automated lathes operated according to strict cyclical programs that require practically no adjustment. Therefore, the assimilation of new items requires certain major investments. If existing equipment cannot be used for new production, then the investment will be considerable and with the next change of production, the technological equipment may again turn out to be useless. The cycle of production change continues to diminish. Thus, for example, the period of renewal of computer technology amounts to 4-6 years while microelectronic technology which forms the basis of computers has an even shorter life of 3-5 years.

Modern consumer demand for industrial products is such that even the list of mass-produced articles should be expanded. This is also true of common consumer products and items of industrial production.

It is a natural desire to realize new production with minimal loss and costs and be able to conduct even small-series and multiple-item production with such characteristics of large-series and mass production as rhythmicity, high rate of production and stable technological processes.

"We need revolutionary advances such as a switch to completely new technological systems and the latest generation of equipment of the utmost efficiency. In essence, this requires the rearming of all branches of the national economy with the latest achievements of science and technology...Our main task is to quickly switch over to the production of the latest

generations of machinery and equipment that can be used to introduce advanced technologies, multiply worker productivity, reduce material consumption and increase investment returns. Our chief attention should be aimed at perfecting machine building and accelerating the development of computer technology, attachments, electrical equipment and electronics as catalysts of scientific and technical progress". This was stated in the documents of the April 1985 Plenum of the CPSU Central Committee.

The plants of the future look like those envisioned by science-fiction writers. Automated production, waste-free technologies, an abundance of robots and electronics, more complex equipment...However, today we can still see yesterday's equipment in our factory shops. For modern technology to become a customary sight and make the equipment of industry with new technology a real prospect in the coming years, we need the united efforts and intensified creative work of engineers, designers, scientists and innovative industrialists.

Such work has already begun. In the industry of Moscow alone, there are now over 200 robotic complexes at work and about 2000 robots, manipulators and automated machine operators. Since the start of the 11th five-year period, more than 900 shops and production sections have been comprehensively mechanized and automated. Large-scale joint work is being continued by the scientists of the Experimental Scientific Research Institute of Metal-Cutting Machines and the Dinamo Factory to create a roboticized shop at that plant. At the Red Proletariat Factory, there has been created an is successfully operating several production sections where the service of metal-cutting machinery has been automated.

These tasks, however, can only be fully solved by flexible production systems.

FMS Control Systems

An integrated system of flexible automated production based on modern computer technology is the basic component of FMS without which it cannot exist. Even if we are create an automated shop or even whole plants that have the outward signs of flexible production (NC machines and equipment, robots, storage, transport) but the control of such production, even computerized control, does not constitute a single technical, programming, data-processing and organizational system, we still do not have an FMS.

An integrated FMS control system is built on the basis of integration, hierarchy, flexibility, modular structure, operational autonomy and stability.

As an integrated system, an FMS control system consists of a series of basic functional systems that form an interconnected complex.

The technological equipment automated control system (ASUTO) controls the technological equipment and mechanisms, the reception and processing of data from process sensors and regulates parameters, performs computer operations (for example, linearization of sensor signals, etc.). The technological

process automated control system (ASUTP) in an integrated production system takes data received from interoperative control posts to create a model which it then uses to correct the technological process parameters (operation time, process temperature, reagent consumption, etc.). The task of the automated transport and storage system is to load blanks, unload and store finished parts and supply these parts to certain equipment, sections and lines as well as to other shops. Within an integrated FMS control system, the automated system of technological preparation of production (ASTPP) is highly important. The basic task of such a system is to assure that the flexible production system is technologically ready to produce planned items. The functions of this system in integrated production are: development of the technological machining process; design and production of technological fittings; provision of reagents; purification of reaction chambers and working containers such as the quartz boats for physical and thermal equipment; and the manufacture and quality control of phototemplates, etc.

The basic purpose of an automated system of automated working dispatch control system (ASODU) is planning and dispatching the work of flexible production sections and shop lines. The control system of a flexible production system operates in real time: on the basis of the planned task, data on the course of the technological process and data from the automated production technological preparation and automated production control systems.

In an FMS working dispatch control system, modelling gains an entirely new significance. Whereas in traditional production, separate organizations or subdivisions apart from industry itself were involved in studying the course of production, comprehensive modelling and simulation in FMS forms an organic part of the production process because flexible adjustment and an FMS control system demand continuous analysis and development during operation.

The key problem in creating FMS is automated quality control of manufactured items. For example, a comprehensive approach to automated control of the production of electronic devices requires establishment of a close correlation between the quality control systems (ASUK) operated at plants and the technological process control systems. For various items produced by the electronics industry, it suffices to effectively solve the large-scale problem of creating quality control systems. The quality of produced items is formed while they are being manufactured but it has already been planned during the early stages of development and manifests itself during operation. The generalized scheme of providing, controlling and regulating quality can be represented as a feedback system. Its realization can be illustrated in the example of the complex tasks involved in designing and producing internal circuits and micro-electronic apparatus. We can break this down into three sets of quality-control tasks.

During the development stage, the first set of tasks consists of:

-- functional and logical design (monitoring the correctness of the logic circuit according to time algorithms, lexical and semantic rules, analysis of the accuracy at which errors are covered by means of monitoring and diagnostic tests, etc.);

-- technical schematic design (establishing electrical condition schedules, evaluating reliability, etc.);

-- structural and technological design (monitoring the technology, durability and thermal calculations, etc.);

-- technical preparation for production (preparation and checking of technical documentation, production and monitoring of phototemplates, etc.).

The second set of quality-control tasks consists of those performed by the technological process automated control system (preparation of integrated circuit and large integrated circuit semiconductor structures, passive parts of microcircuits), automated interval control and item-testing systems as well as dust, humidity and temperature control systems which are highly specific for the electronics industry.

The third set (the level of control of the production of automated working dispatch control systems and automated plant control system) includes tasks such as planning preventive maintenance of equipment, calculating the results of starting control of materials, prefabricated parts and components, technological losses and parts failures during production, etc. The tasks of the automated control systems for technological processes and production considerably overlap tasks handled by the automated quality control system.

In the opinion of Japanese specialists, the traditional quality control system are useful as long as the amount of defects of waste does not exceed one percent. However, traditional quality control methods are not useful when it is necessary to produce items for which the defects amount to 0.01 percent or less (as is the case with FMS). The Japanese experts feel that high quality is rightfully the responsibility of the plants' production personnel which at every work post checks the quality of each technological operation. This means that the existing quality control should be replaced with production process control. In this case, starting control of all materials and components is very carefully carried out but most of all, the condition of production equipment is closely checked and breakdowns that can result in defects are prognosed. Practice has shown that even these measures are not enough. There should be a system that can provide high product quality beginning with its development, through all stages of design and production on to maintenance after sale. This system is known as TOC (Total Quality Control).

Along with high quality, the Japanese system also provides high labor productivity since only quality production goes into process and neither the workers nor the equipment are involved in the preparation of production which may in the end turn out to be defective.

The second characteristic of this system lies in the fact that everyone employed at the plant is responsible for quality, each in his own section, and this requires a high degree of conscientious work on their part.

The flexibility of a production system depends to a great extent on the functioning of the computer-aided design system (SAPR).

The high requirements on the technical sophistication of items (their complexity, modular design, standardized starting and end parameters, etc.) can be fully satisfied only with a switch from traditional (manual) design methods to automated design based on the use of computers. This is due to the fact that the formalized design methods that are the foundation of computer-aided design which is based on the principles of modular design, group technology, standardization and unification naturally matches the requirements of modular construction, group processing and assembly of identical items. The use of computer-aided design makes it possible to subsequently automate all stages of production process, reduce designing time and optimize constructions and technological processes.

The control systems for scientific research (ASNI), design work (SAPR) and the automated plant control (ASUP) are closely associated with the automated on-line dispatch control system and the production technology preparation control system.

The automated scientific research system is highly important in the creation and functioning of the "development-production" system and performs systems analysis of all forms of production and its separate elements, carries out mathematical, imitative, seminature and nature modelling and modelling of systems and technical processes and generates recommendations on equipment and software for flexible FMS adjustment.

What is more important in determining what unites all of the separate systems into an integrated FMS control system? If we assume that the technological equipment and FMS devices are capable of technical and program adjustment, then this itself can be done on the basis of an interconnected complex of algorithms making it possible to decide the final function of an FMS, its readjustment.

Software realization of a set of algorithms and the organization of FMS production makes it possible to determine individually for each flexible production system how to reach an assigned goal and what and when should be done for this purpose by various services and specialists of industry, devices, installations and control systems.

The basis for mutual "understanding" of all equipment, systems and people working in production is unified data-processing software for FMS which can be presented in the form of groups of data reflecting all of the objects of production, planning, designing, their properties and inter-relations.

At the present time, we already have gained a certain amount of experience in designing subject data bases oriented at concrete applications but we have no experience in creating integrated data bases. Until we master this problem, we can only partially realize our concept of FMS.

A highly important question in an integrated FMS control system is how to establish some form of interaction between the automated systems for scientific research, computer-aided design, plant control, technological production preparation, etc. Each of these systems will work satisfactorily in its own "closed" environment, that is, in an environment of control objects, algorithms, data-processing and software related to the circle of tasks handled within that system. But how are we to give these separate systems enough "openness" to allow them to freely cooperate with other systems? The methodology and work organization should be the type that can provide a unified approach to analysis of diverse requirements and specifications of concrete applied tasks solved with the use of information from various systems? What sort of standards necessary for creating such an "environment of open systems" that would create the possibility for further development with regard to new requirements on FMS control systems and improvement of computers and data-transmission equipment?

At the present time, the integrated FMS control system reminds one of a 20th-century Tower of Babel where, with such a multitude of languages, it is difficult to organize interaction between different systems. In May 1983, the International Organization for Standardization accepted a standard for determining the base architecture of interconnection between open systems which is oriented to a nonuniform medium (computer equipment) comprising various items made by different manufacturers. The effective open connection between united systems is possible with the use of data-transmission systems that strictly observe standardized procedures.

The basis for the hierarchical principle of designing automated control systems and FMS is division of control functions in which the interaction between levels provides interaction between elements of the same level. In divided a control system into control levels, one must consider that computers of higher levels will solve larger tasks and also have a longer period to make decisions and, in comparison to the computers of lower levels, will less frequently generate control signals.

Hierarchic organization makes it possible to optimize data processing by reducing the dimensionality of tasks at each level. This therefore frees communications channels and makes it possible to redistribute tasks from the emergency elements to the operating elements. Within the range of given tasks, the system can work independently at every level for a certain period of time. Building an FMS control system on the principles of hierarchy and autonomy of each control level makes it possible to create them in stages and also permits modular construction which in turns makes it possible to typify and unify engineering solutions in designing control systems by using a basic set of standard equipment and program components with given functional capabilities. Thus, for example, the use of data memory as part of the control equipment (independently powered internal memory, cylindrical magnetic bubble memory, floppy disks) makes autonomous functioning necessary over a period of time. Modern computers are used as control devices in all functioning FMS systems.

The first domestic 12-bit Elektronika-100 minicomputer could solve a series of problems connected with controlling technological processes and creating control and testing equipment. The switch to development and production of large and super-large integral circuits substantially broadened the uses of minicomputers and raised requirements on their functional characteristics, the result of which was the creation of a series of program-compatible 16-bit minicomputers such as the Elektronika-100-25, the Elektronika-100-16I and the Elektronika-79. Development of the Elektronika-100-25 solved more important problems, above all the creation of an automated system design system and multipurpose measurement complexes. Computer-aided design can be handled on a completely new level by the use of the universal high-speed Elektronika-79 minicomputer which has now begun to be manufactured.

The creation of high-speed minicomputers has in turn led to quick development of electronic technology. Growth in the degree of integration of large integrated circuits requires constant development of computer-aided design systems, growth of their computing capacity and an increase in the functional possibilities. Intense work is being conducted to develop complicated items of computer technology and a prospective base of components.

To satisfy the demand for computer-aided design systems, a new series of 32-bit minicomputers is being designed. These minicomputers are characterized by enhanced precision, powerful system command and the greater capacity of their internal and external memories. The new series of computers is software- and hardware-compatible with 16-bit computers. This makes it possible to use applied software already used by consumers. The development of 32-bit computers has substantially increased the productivity of computer-aided design. If a computer-aided design system with an Elektronika-100-25 computer is used to design large integral circuits consisting of as much as 32,000 elements and the Elektronika-79 computer is used in the same system to design circuits of up to 300,000 elements, then an Elektronika-82 can be used to design circuits of as much as two to three million elements and this makes it possible to develop a large base of elements for computer technology.

Successes in microelectronics and experience in the development of minicomputers have made possible the Elektronika-60 which has better technical and economic characteristics than all of its predecessors.

The architectural and circuit design of the Elektronika-60 have allowed creation of program- and hardware-compatible single-plate Elektronika NTs-80-01, Elektronika-60T, Elektronika-C5-41 and the Elektronika NTs-80-01D minicomputers. These new models have incorporated all of the latest achievements of microelectronics such as super-large integrated circuits, noncommutable logic matrices, optimal technology, etc.

For those areas of use in which the basic criterium is cost and small size, there has been developed the Elektronika-60-1 made from a microprocessor set of n-channel MDP [not further identified] large integrated circuits. It is distinguished by substantially improved characteristics such as twice-higher speed (600,000 operations per second) and a fourfold increase in its internal memory (up to 1 megabytes).

Part of the series of single-plate minicomputers is the Elektronika C5-41, Elektronika NTs-80-01D with a speed of up to 0.8 million operations per second, compatible on the command level with the Elektronika-60.

Work is being conducted to create dialogue-capable computer complexes. On the single-plate basis of the Elektronika NTs-80-01D minicomputer, there has been created a complex of the Elektronika-80/20-2 with an electronic beam tube display, autonomous thermal printer and Elektronika NTs TM 6022 floppy disk memory. There has also been developed the higher-power dialogue-capable Elektronika-80-20/3 computer complex which is the basic medium of control systems as well as design systems.

The requirement for quick adaptation to changes in production conditions and resetting functions for changes in the size and nomenclature of production is satisfied by a system created from the Elektronika NTs-80-31 SChPU [probably numerical control system] which is designed to control revolving equipment such as lathes, mills, grinders lathing aggregates, all-purpose lathes, multipurpose machining aggregates, metal-casting machines, forge and pressing equipment, automated storage, etc. Its universal hardware and the continuity of its software has made it very useful in flexible manufacturing systems. The computer part of the different types of the SChPU NT-80-31 numerical control system is made from the large integrated circuit of a K1801BM1 microprocessor which gives the computer its necessary high speed.

The system has an independently-powered built-in spare cylindrical magnetic bubble memory made in the form of a small cassette. The reliability of the NTs-80-31 system comes from a series of circuit and structural solutions. The use of code protection of the internal memory and the cylindrical magnetic bubble memory as well as the maximum reduction of the number of integrated circuits of low and medium degree of integration and the simultaneous realization of functional units chiefly in K1801-series large integrated circuits have made it possible to create reliable and relatively energy-efficient devices. The numerical control system was made in a dust- and splashproof design with single-circuit forced cooling without suction of external air. The system has been included with noise protection for the drives and pickups. The reliability of the NTs-80-31 is provided by a complex of production and technological precautions during its manufacture; 100-percent electrothermal pre-burning of the component parts and 100-percent equipment and minicomputer electrical thermal run [elektrotermoprogon].

The built-in mathematical software makes it possible to connect the NTs-80-31 numerical control system into a network of flexible production cells and for the system to communicate with an upper-level computer over a standard telephone cable. The use of modern devices in the computers and system for transmission of data to the FMS makes it possible to create distributed systems of data control and processing, local computer networks in which the technological equipment, robots, storage, control posts and other FMS devices are subscribers to the necessary data received from other subscribers.

Microprocessor Systems for Controlling FMS Technical Means

Microprocessor systems for controlling technical equipment form the very lowest level in the hierarchy of FMS control systems. It is namely these control systems together with technological equipment that provide the necessary flexibility to production modules and the storage and transport systems.

The process of creating semiconductor structures from silicon sheets requires great precision in the measurement and stabilization of many parameters such as time, temperature, gas consumption, etc. The subjective factor of operator skill therefore becomes especially important. In the electronics industry, the cost of production losses due to poor training of workers considerably exceeds the cost of similar losses in other industries. In a complicated technological process, even skilled operators are not able to repeat processes at a high rate and this to considerable variation in the parameters of the items being produced. A growth in the productivity of technological equipment through an increase in the amount of simultaneously processed sheets leads to more expensive defects which in certain cases can amount to tens and hundreds of thousands of rubles.

The constantly expanding number of items being produced requires flexible and quick adjustment of the entire production process. These demands can be met with the use of microprocessor systems to control specialized technological equipment which makes it possible to realize both traditional control functions and an entire series of new functions.

Diagnostics and monitoring constitute one of the key functions of a control system. They check the control system itself, including its microprocessor part. Therefore, in the development of new technical means for a control system, it is necessary to make it possible to monitor and determine defects in the internal and continuous memories and correct the functioning of the modules for connection with the production object and of the normalizing converters in the circuits of the parameter sensors. Special test programs within the software reveal defects and give operators the proper data.

Checking and diagnosing the state of separate equipment systems (vacuum, gas, locks, etc.) may be carried out through an abbreviated work cycle (in cycle-action installations) or by means of checking the correctness of all systems when they are being prepared for work. In designing a diagnostic system, it is necessary in many cases to install special sensors that record the state of the system. A series of parameters can be checked algorithmically: for example, the speed of evacuation of the working space is determined by the magnitude of the assigned pressure and the time it takes to reach that pressure. The condition of many mechanical systems can also be determined according to how long it takes them to execute a command.

A very important aspect is metrological diagnosis and its final result, metrological certification of the equipment. This function, which because of the complexity of its metrological standards and tests, has not been used as much as it should but some components of this form of diagnosis have already

found application in new equipment. The availability of corrective programs makes it possible to make zero-level corrections during measurement or to correct the graduated characteristics of sensors (due to "aging") as a result of statistical observations.

Programming is the function of the microprocessor system which makes it possible to change on line the parameters of cycle of the technological process and this is extremely necessary in the multi-nomenclature production.

For the operator and technician, organization of programming in the form of dialogue in which the microprocessor control system itself presents the list of parameters, the length of assigned parameters (and in several cases, the recommended parameter, too) on the display screen simplifies programming and reduces the number of possible errors. The ability to review all possible parameters allows the technician to reassure himself that the mode assigned the technological process is the correct one. Some of the service functions provided by the software do not allow the introduction of any parameter value outside of allowable limits. If the technician already knows what technological processes will be realized on a given piece of equipment, he can then program and save several processes and recall them from the memory as they are needed.

Designing a control program is the chief function of the control system which sequentially controls the technological cycle and process parameters. Considering the design, it is necessary to note during the development of specific technological equipment control systems which combinations of technical resources are possible: microprocessor monitors of the control of the cycle, parameters (so-called remikonts [not further identified]), analogue regulators and separate circuits of the logic control including the relay circuits.

In relation to the volume of monitoring signals and the necessary control actions, the microprocessors can fully realize discrete and parameter control (indirect numerical control) or carry out the control process in combination with other devices realizing "hard" logic of control (the "command-command" type) and numerical and analogue regulators. In the second case, the technical equipment of the microprocessor system take on part of the control functions, transmit settings to the analogue regulators (or separate numerical regulators) and coordinate the work of all components.

The use in control systems of microprocessors and minicomputers makes it possible for the developer to realize process parameter control algorithms which traditional control equipment cannot realize. A system can be built with variable parameters of PID-law (proportional-integral-differential) regulation tuning and algorithms can be realized for a control system with changing structure, etc.

Promising developments are offered by the creation of algorithms of adaptive control in the measurement of parameters of the controlled object during the technological cycle and the system self-tuning to any given characteristics of the production object.

An important function is the correction of process parameters according to the results of interoperational monitoring and technological conditions. Like the creation of algorithms for overcoming malfunctions in order to save finished production lots, its realization depends on the people who develop the technology and is a common function of both the equipment and the automated process control system.

A microprocessor system can also include special functions such as calculation to determine the moment that a process changes or ends, the profiling of temperature poles, multichannel regulation, etc. The diversity of such functions is great and as microprocessor technology is assimilated, their number will grow.

Image display and documentation of process parameters is a function necessary for technological processes and in produciton conditions for checking the proper course of the process and its certification.

In ORION-3 control devices, a 15IE-00-013 display is used. This display allows the operator to receive data in any form he needs. Direct connection of the numerical printer to the technical microprocessor is impossible. However, the use of a telegraph channel (sequential "current loop" type interface) allows the line, section or shop dispatcher post to call up and receive necessary documents.

The communications between the technological equipment control system and the higher-level system can change from mere units in simpler equipment to hundreds and thousands in larger technological complexes. In just the same way, the number of technological parameters can differ substantially in various installations.

This principle should be used to build the technical devices for controlling equipment so that they can easily be modified to satisfy the developer's control system as to the necessary amount of input and output signals, the maximum signal strengths, conversion precision and other parameters? Such a principle is the line-modular principle which also serves as the basis for designing microprocessor control devices. This principle was first used on a wide scale in the development of firm-designed and international systems of the KAMAK and VEKTOR unified modules used to create control systems in nuclear physics. They possess two invaluable advantages: compatibility in which each module system's construction and interfaces are strictly standardized which allows consumers to use modules to put together their own systems; and flexibility which allows rapid growth, modernization and reconfiguration of control systems.

Modular design of technical equipment makes it possible to create complexes of varying complexity to control technological equipment. Typical representatives of such domestic microprocessor control devices are the Orion-3, UTK-5 and others. An Elektronika-60M computer is used as the central processing unit in the Orion-3. The control device receives and sends out discrete and analogue standard signals. The total maximum number of discrete input signals is as high as 160 while that of output signals can be as high as

80. As much as 32 and 16 (respectively) analogue signals can be generated. Input and output signals are converted with the use of a high-precision 12-bit converter. Using a 15IE-00-13 display, the operator can communicate by dialogue with the control system. On the basis of Orion-3 control devices, control systems for many different types of special technological equipment (plasmochemical, vacuum and physiochemical equipment) have been created. In these systems, the microprocessor devices and control programs carry out practically all basic control functions. In the case of the control of plasmochemical equipment, we will show how such systems are organized.

There have now been created installations for group and individual plasmochemical processing with a fully automated cycle of single- and multi-stage technological processes. The control systems are built on a hybrid principle combining central control and local systems. Centralized control of the installation is provided by microprocessor devices that use the Elektronika-60 minicomputer within the Orion-3 control block.

The basis for microprocessor control is the principle that the entire control process can be divided into cycles. The control cycles start with the appearance of a synchronized stroking signal generated by a timer. Each cycle starts by polling the sensors whose signals enter the signal reception module of the Orion-3. The microprocessor system analyzes the information and acts on the executive devices in accordance with the control program algorithm.

Analysis of the structure of the control system has shown that the best structures were those in which the individual parameters of the technological process are stabilized by autonomous regulators while the microprocessor system (microprocessor control system) processes signals from the discrete and analogue sensors, displays necessary information on the screen, signals breakdowns, realizes the control algorithm and computes the control action of the automatic regulator. Such a control structure improves system reliability as a whole because it remains able to work even if the computer malfunctions. Along with this, regulation of the most important parameters (such as the temperature of the thermostat and evaporator) and processing the signal from the process conclusion sensor are transferred in their entirety to the computer.

Functional installations of plasmochemical technological group and individual processing are divided into a series of local systems: the temperature stabilization system in the reactor, the temperature stabilization system of the evaporator, the reaction gas consumption stabilization system, the system for stabilization of the level of liquid nitrogen in in the trap, the process conclusion control system and the system for stabilizing the power of the high-frequency generator.

Regulation with the microprocessor control system is carried out according to the proportional-integral-differential law. In automatic mode, the temperature is assigned the installation by the microprocessor control system. In accordance with the control algorithm, the microprocessor generates a 0-10 V analogue signal. One of the most important parameters of the technological process is the pressure in the chamber. In plasmochemical installations of

group and individual processing, the pressure is stabilized by a local system. In adjustment mode, the pressure is set manually while in automated mode, it is set by the microprocessor control system. The signal characterizing pressure and taken from the pressure indicator output and converted by the ATsP [not further identified] microprocessor control system into numerical code.

The microprocessor control system calculates and generates a control action in the form of the best setting. The display screen shows the current and assigned pressure values as well as the emergency condition of the evacuating system. Under critical malfunctions, the microprocessor control system switches into adviser mode.

The system for regulating the power of the high-frequency generator realizes two modes: adjustment and work mode. In adjustment mode, a local system stabilizes the generator while in work mode, the microprocessor control system does this. The loading and unloading of plates takes an important place in the control system of a plasmochemical installation.

The use of microprocessor control devices has made it possible up to 98-percent uniform processing and also allows the use of any one of 9 programs without any readjustment. This has improved process control under changing production. The program for processing the signal from the sensor for conclusion of the pickling process and switching off of the pickling process has enhanced data-processing selectivity.

In vacuum equipment, the microprocessor system programs the installation's work mode, displays the given program, executes the program, provides pre-startup checking of parameters, diagnostics, etc. At the same time, 9 processes can be programmed and any one of these can be called up at the choice of the operator. The greatest effect of introducing microprocessors is that they make it possible to control the technological process with regard to principles that cannot be realized in traditional local control systems. The current and voltage sensor signal microprocessor regulates the power of the magnetrons, counts the energy lost to spraying, finishes the spraying cycle according to the assigned energy level, allows for wear on sprayed target according to the magnitude of the total energy lost by the magnetron in all of the spraying cycles in relation to target erosion, etc. Consideration of these factors makes it possible to reduce differences in the thickness of the sprayed film by as much as 5 percent and excludes the necessity of correcting the spraying process. In a similar installation without microprocessors, the difference in the film thickness is 10 percent and the installation has to be adjusted twice each work shift after trial sprayings.

Along with equipment in which the microprocessor system centrally performs control functions, there is technological equipment where similar centralization of functions does not make it possible to perform the technological process with the necessary speed and precision. Such equipment is welding and assembly equipment for transistors and integrated circuits.

Typical functions of the control device for multipositional automatic welders are automatic determination of the magnitude of displacement and the turning angle of the boiled crystals relative to the base angle; synchronization of the appearance of data on the alignment at the weld position with the displacement of items within the loader; control of the loader; simultaneous control of the 6-step drives of the welding heads with interpolations of instrument displacement along the X-Y-Z coordinates; calculation of actual welding points on crystals; diagnosis of welding processes; self-diagnosis; collection and processing of data for the technological process automated control system; dispatching the work of automation components and organization of work in general.

The large amount of computer and control tasks, diversity of functions, requirements for high productivity and increased "intellect" of the automated system have determined the design of its control device. It is built from a distributive microprocessor system where the use of K580 IK80 microprocessor autonomous controllers makes it possible to independently solve a given circle of tasks and relieve the central controller of organization and dispatch tasks.

Today, the development of microelectronics has made it possible to place on one printed circuit board all of the necessary controller functions using fragment-module design which was first employed to develop Elektronika S5-41 single-board microcontrollers.

The essence of this method is that the surface zone of a printed circuit board used to hold radio elements is divided into sections of standard size and shape. Within the area of a standard section, the topology of a functional module with a built-in systems interface is designed. This creates a library of functional standard fragments of modules of interface, structural, technological and program compatibility. The method makes possible rapid creation of single-board items of the required shape.

Development of single-board microcontrollers for the reception and output of analogue and discrete signals allows one to use various software within the PZU [not further identified] which is located in this board of the microcontroller to form a series of control devices such as "time-parameter", "time-command" and "command-command" programmers, multichannel regulators, etc.

Further development of microelectronics has led to the creation within one super-large printed circuit [SBIS] of an entire system including a central processing unit, OZU [not further identified], PZU, programmed inputs and outputs, ATsP [not further identified], TsAP [not further identified] and has also recently led to small distributive control devices which give a control system even greater flexibility.

The results of using computers depends to a great extent on how well the user can work with that computer and therefore it has become increasingly important to develop means of oral communication between the two.

Oral communication in man-and-machine systems is convenient, natural and simple. It does not require any special training and also increases the number of potential users for automated control systems. Oral communication makes it possible to take over the output of data from visual channels and eliminate manual manipulation in data input. This increases the operating potential of the system and reduces the number of operator errors. It also makes it possible to use normal telephone equipment in place of terminals which substantially reduces the cost of introducing man-machine systems.

The multiprogram MARS-1 speech-recognition and synthesis system is designed to provide oral communication between the operator and computer. The system should both automatically identify a speech signal with one from a previously-selected class (speech recognition) and create artificial speech signals (speech synthesis). The combination in one device of speech recognition and synthesis creates new possibilities for use of speech devices in control systems, especially in the processing of data when it is necessary to record interval results and at the same time input new data and instruct the computer.

Programmable controllers have found wide use in special technological equipment control systems. According to a 1978 agreement, they are defined as "a numerical electronic device that uses a programmable memory to store instructions necessary to perform such special functions as controlling the sequence of signal output, counting time, calculations and also arithmetic operations and logical functions by which numerical and analogue input-output modules can control various types of units or processes". The basis for the logical functions of programmable controllers is their combined logic and they are often programmed with the help of relay-diagram logic. The appearance and development of programmable controllers is one of the manifestations of a modern trend toward replacing electrical relay circuits and even electrical circuits having a "hard" (fixed) structure with freely programmable (adjustable) structures.

More than 80 percent of all foreign-produced programmable controllers are from Gould's Modicon Division, Allen-Bradley Company and Texas Instruments, Inc (USA). The following three types of programmable controllers have been most used in control systems. The first type is controller oriented at realizing logic algorithms. These are used to replace various relay and logical circuits in electronic automation. The second type consists of controllers oriented at realizing algorithms for automatic regulation of analogue and analogue-discrete technological processes and are intended to replace various types of analogue and numerical regulators. The Soviet-made Remikont and Orion-1 controllers are representatives of this class. The third type consists of controllers used to realize special control algorithms and to control complicated machine tools, control and measurement devices, transport and storage mechanisms.

A typical representative of this third controller type is the Elektronika NMS 12402.1 programmable controller which is designed to control discrete and noncontinuous-action technological equipment (lathes, automated lines,

manipulators, etc.) and can be operated both independently as well as within a numerical program control system.

Equipment is controlled according to a specific algorithm composed in the form of a relay-contact circuit and written into the PPZU [not further identified]. The programmable controller contains an all-purpose computer, a logic operations block, as many as three electronics automation circuit boards and a power unit. One of the electronics automation boards can have 64 inputs and 32 outputs. The programmable controller forms part of the Elektronika MS 2101.02 numerical control system which controls multipurpose machining lathes.

Special technological equipment equipped with loaders and unloaders (which can be specialized robots) and united to form a functional technological aggregate are from the point of view of production organization flexible production modules. A special minicomputer or microprocessor system takes on itself the function of controlling the module to provide the necessary internal dispatching and communication with higher- or lower-level MPSU [not further identified] and minicomputers.

Monitoring between operations has a very important role in the production of printed integrated circuits. Because it is impossible to measure semiconductor parameters and other structures created in the technological process, the intervals between operations are monitored at special monitoring points. One of the basic processes of integrated circuit production, the splicing of epitaxial silicon layers, is a periodical operation within the group processing of circuit boards. By the conclusion of each cycle, the thickness and resistivity of the produced layers are selectively measured and these measurements are then used in the next process to correct the splicing by orientation for the assigned values of electrical and physical parameters.

The automated control system for the technological process of epitaxial splicing according to an adaptive mathematical was developed from Orion-3 microprocessor control equipment and has shown a rather high degree of efficiency. Such a system completely excludes any need for operator involvement for feedback between the parameters obtained and the technological mode. Feedback within the system is achieved by means of correcting the technological conditions for layer growth that were assigned between splicing cycles. During the process, the mode parameters are kept at assigned values with the help of the MPSU. According to the results of several series at a level of 30-40 sequential splicing processes, the accuracy of adaptive-model automated control for the given nominal value of the parameter was plus or minus 0.6 percent for thickness and plus or minus 7.5 percent for resistivity. The quality indicator of 30 percent was higher than it was without the control.

On the basis of separate units of STO [not further identified] and technological aggregates are formed flexible production sections and flexible production lines that work in close organization and technological cooperation with other sections and lines.

Silicon sheets produced on one line or section are set aside for the next stage of processing and kept in a special dust-free container in interoperation storage. The structure of the storage, transport devices, as opposed to similar devices in machine working and assembly, possesses many specific structural features that allow storage and transportation of entire lots of silicon sheets without direct contact with the shop atmosphere.

Nippon Denki's automated continuous production line for producing integrated circuit structures is an interesting system. The line consists of four production modules, a rinsing and etching module, a diffusion and oxidation module, a photolithography module and a spraying module. These modules are connected by transport devices and are centrally controlled by a computer. The diffusion and oxidation module, the most automated part of the line, consists of three independent sections. Cassettes with sheets are transferred manually from one section to another. The module includes bins for "extended" and "working" storage of sheets. On a computer command, sets of sheets are taken from the bins for processing. A signal from the operator's panel moves the computer-assigned over a conveyer belt into the pressure chamber. The sheets automatically pass through rinsing and are fed onto the platform before the proper channel of the diffusor. A special loader feed a quartz boat holding the sheets into the diffusor's reactor and returns the boat to its starting position. The module has a diffusion control panel which is used to set processing parameters and to correct the process if the parameters deviate from their assigned values.

An essential element in the design of this automated line is the arrangement of modules using identical equipment according to the cyclical nature of the sheet movement during production. This considerably reduces the overall length of sheet transport. The basic function of the control system of such a line is operative-dispatch control. The data-processing and control complex based on an Elektronika-100-25, Elektronika-79 or Elektronika-82 minicomputer is the main shop complex and together with the work places of the technicians, programmers and service personnel, forms the sole complex of computing equipment connected both to each other and to the plant computer center by a data-transmission system.

Local Computer Networks for Distributed Control Systems and FMS

Analysis of the principles of control of technological processes and FMS has shown the necessity of high-speed processing of parallel data flows from distributed terminals (of sensors, executive organs and technological equipment), integration of data-processing and computing equipment, real time scale (little time lag) in the gathering and transmission of data, reliability, a robust and flexible control system, working interaction with systems of both lower and higher hierarchical levels. This entire set of requirements has been to a considerable degree satisfied in control systems using the principle of local computing networks that highly enhance computer efficiency through more rational use of system hardware and software, improvement of their operating characteristics and easier operator-computer interactions. Local computer networks are a system of distributed data-

processing within the plant and share a common communications channel over which data is transmitted.

The concept of a computer network is based on the architecture of open systems interaction which provides communication of various equipment and computers with the use of certain rules (protocols) organized in some hierarchical image, i.e. divided into levels or layers.

For operative exchange of data between network subscribers (NC lathes and equipment, storage, transport, robots), a communications channel with a high carrying capacity of as much as 1-20 million binary symbols (bits) per second (1-20 Megabits/second). Before long, data will be transmitted at an even higher rate and this will make it possible to solve new tasks down to the level of parallel operation of several computers connected to the network.

The basic structural schemes of the local computer network that have been found to be more useful in various applications (institutional automation, data-processing, computer-aided design, automated control systems, technological processes, automated research, etc.) are as follows: a monochannel based on a shared trunk line, ring, star and tree (polychannel).

The monochannel network includes a monochannel based on a twisted pair of wires, coaxial or optic-fiber cable, subscribers and mating devices with transmitters realizing the protocols of the lower levels called stations. The output of such a system is determined by the characteristics of the transmission medium, number of stations and their carrying capacity. In this case, optic-fiber cables seem to be best as they provide high-speed data exchange (up to 100 Megabits/second and higher) and excellent noise protection. Since overcoming certain mating (interface) difficulties have been overcome by the use of optical mixers, fiber technology is being widely used in local computer networks. At the present time, turned pairs and coaxial cables are being used everywhere as the physical line. To increase network length, amplifiers (repeaters) are hooked into cable breaks to compensate dampening and regenerate the signal. Such a monochannel is called an active channel. It consists of passive shared links (segments) each of which can, as a rule, transmit data signals in two directions, and an access unit connects the subscriber subsystem.

As part of the general physical medium, separate channels can be organized by breaking down the total carrying capacity of the medium into parts. In this case, we come to the principle of the polychannel allowing transmission of data streams of various properties in a certain part of the overall channel.

In the ring scheme, the common link for transmission and one-way transmission of signals is provided by access units. At their connection points, repeaters are installed to prevent the data flow from one subscriber to another from recirculating around the ring.

The star-shaped topography of a local computer network assumes the presence of a junction where the paths taken by data signals from various subscribers cross. The junction may contain a data distribution system (commutator). In

a local computer network, the commutator is made from electronic circuits that provide "rapid" transmission of data in the required directions. With the use of optic-fiber cables, the commutator acts as an optical mixer.

The robustness of a local computer network with such a centralized structure is determined by how reliable its units are because if one goes out of order, the entire network is disrupted. Trunk-line or ring networks based on decentralized control of data exchange between subscribers are very robust.

A tree-form network has star structure and is a very convenient form for centralized data gathering and processing systems.

Because of certain advantages offered by trunk-line monochannels, more attention is being devoted to local computer networks with a "general wire" topology. It is just such a topology that it characteristic of the majority of contemporary local networks.

In contrast to large territorially-distributed computer networks where the subscribers are interconnected by multi-unit commuted data-transfer networks and in which the data tracking path is selected using a routing procedure, the little networks provide direct subscriber interaction.

Connections with a local computer network are based on the access method which determines the lag in communication directed from a terminal (or computer) i to terminal (or computer) j as well as the load level (use coefficient) of the transmitting medium.

Access control performed by the access station or block provides subscriber multiple access to the monochannel. The asynchronous nature of their operation, i.e. the occurrence of requests for standard-length data-transmission in every terminal independently of others, requires that the users follow discipline in the sequence of network use.

There are two classes of access methods: determined and coincidental. Each of these has its differences. Let us examine them from how they transmit data, which is an aspect that is highly important to the elements of an FMS.

The simplest method for breaking down the resources of the transmitting medium is to present the channel sequentially to each terminal. Such a discipline is too rigid. The channel is offered to the user for a specific amount of time regardless of whether he has information to transmit, how long the transmission must be and how it is to be transmitted. If the subscribers are not very active, the channel will not be used efficiently and the time lag may be too great.

The "relay" method is more efficient because it is only the active subscribers that divide the communications resources of the local computer network. The order in which the channel is offered is assigned either according to a specific schedule which is constantly updated or by transmission to the terminals completing their connections, giving one terminal priority over another by sending it "the relay baton". There are also used other

modifications of this method that consider subscriber priority and the allowable lag and resolve conflicts on a set basis. Such a method is attractive for collecting, transmitting and exchanging data on low levels of an FMS control system.

Coincidental access methods are based on presenting the channel on demand. Because requests for channel use can be made independently, there can be "competition" for access to the common resource (the transmitting medium). The desire to simultaneously provide operative data transmission and a high level of channel loading has met certain barriers. These are overcome by making the simplest procedures of coincidental access more complicated.

In coincidental access, the subscriber begins to transmit information without any mutual coordination of his actions before the start of transmission. If during the transmission, no other subscribers request use of the channel, the transmission will be successful and this is determined by the subscriber after he receives the confirmation signal. If messages collide, neither of them can be correctly received. In this case, the subscriber-source makes another attempt to transmit some time after the collision has been revealed. It is obvious that such an access method will work satisfactorily if subscriber activity is rather low. This means that channel is not very efficient. Calculations have shown that its level of efficiency does not exceed 18 percent and that the access time sharply increases as the number of users of a channel of fixed capacity goes up.

The best method of using coincidental access with spacing of transmission moments is one that requires synchronization of terminal work. Transmission is possible only under a spaced impulse. Such a slight complication twice increases the useful network load.

Other modifications involve the procedure of "listening" for signals in a monochannel. The "listen before you speak" method requires that before transmission, the station receivers find messages from other subscribers. Only if the channel is not being used can data be transmitted into the network. In this system too, there can also be a "collision" of messages (because all terminals are in the same circumstances). If a conflict arises, the subscriber tries again to transmit the information.

Finally, such a method can be improved using the "listen while you speak" method. If while listening to the channel the subscriber feels free, he can transmit over his station but while continuing the monitor the state of that channel. If other transmissions are taking place, he can instantly cease transmission to prevent the distortion of his message. Such a method makes it possible to increase the monochannel's use coefficient to 90 percent and lower access time at the cost of complicating the equipment.

Let us now examine the logic structure and programming of a system for transmitting data into local computer networks using the the relay model of open-systems interaction. This model defines requirements on the exchange of the given subscriber systems.

The development of common principles of interaction for open systems and modelling of functions providing communication and applied processes in real networks has led to the International Organization for Standardization's creation of a seven-level relay model. The uppermost level, the applied level, corresponds to the programs of subscribers to local computer networks, i.e. the applied processes of the real world, while the lower levels sequentially exchange information between them. The second large organization, the European Association of Computer Manufacturers, feels that four levels are enough for the architecture of a local computer network.

Organization communication between various equipment and computers within a seven-level hierarchical medium makes it possible to dispense with having to bother about agreement between the characteristics of various devices connected to the network. This is a highly useful feature for FMS elements. The main advantage of the relay model of open-systems interaction is that it allows independent development of typical subsystems protocol service and standards at every level.

How is the interaction of applied processes carried out by this hierarchy of levels? For two objects of the uppermost (applied) level to exchange information, they should ask the next lowest level to make a connection between them through the service access points. In turn, the lower-level objects provide this connection by exchanging protocol data blocks under the control of the corresponding protocol on connection which they request from the next lowest level, etc. In this manner, the given process creates connections from the top level downward through the entire hierarchy of levels until the very lowest level is reached where communication between objects is provided by the physical equipment of the local computer network.

In accordance with this concept, data exchange between objects once the connection is completed is carried out with the help of service data blocks that may contain the protocol data block.

Despite the provision of basic functions for uniting levels and transmitting data, the corresponding service also performs a series of other functions. Some of them are characteristic only of certain levels while others are characteristic of a series of adjacent levels. These functions include error detection, confirmation of transmission and correction of errors caused by losses or distortion of protocol data blocks and correction of the order of block movement if it has been disrupted, etc. These service functions are important in the transmission of control information into an FMS because they assure the integrity and correctness of the data.

It is worth mentioning that it is not always possible to set up a direct connection between objects of a given level (if, for example, the physical means are not available). In this case, the connection between them is made indirectly through intermediary objects of the given level that should be able to route and sequentially transmit the information. Such a situation occurs in distributed computer networks where data crosses through commuting units as well as in the the simpler form found in a single-unit star-shaped local computer network.

Control over the medium of open-systems interaction is exercised by control protocols which initiate, close and process breaks in communications, prevent unexpected shut-downs and coordinate the work of applied processes.

Let us now look at the structure of messages transmitted into a local computer network with regard to the seven levels of the relay model of the International Standardization Organization. At the applied level, the subscriber-source transmits his data to the subscriber-receiver at a certain address without worrying about the peculiarities of the network. If the message is a long one, then it is preliminarily "cut" into smaller parts, the maximum length of which is limited. At the presentation level, the user information is "folded" into an envelope on which the appropriate control program "writes" the necessary address and the session control program adds additional service symbols to the end to prevent possible errors. In general, such an envelope is called a block and the three upper levels of the network's program structure are known as the process (we call it A). When the addressee-subscriber receives such blocks, then the corresponding subscriber-receiver at levels 5 and 6 assembles the original message from them, analyzes it and removes its header and trailer (opens the envelope).

Various processes are found in different subscriber systems such as, for example, micro- and minicomputers and their interaction through lower levels of the program structure. The subsequent path taken by our envelope is "selected" by the transmission control program which reproduces the data block as an entire data file. This in turn places it in "its own envelope" on which it places the transmission header. This envelope is called a fragment. From dispatch port A it is transported along the network to the port of receiver B (or several receivers) along a route chosen on the network level. Then the network control program "packs" the fragment into its own envelope called a packet and "writes" a header on it. In some local computer networks, the function of the network and transport levels overlap in one layer with the program structure.

Finally, the packet on level 2 is put into a frame, i.e. a new envelope, intended for transmission over the physical medium along the data channel. The packet control program sets a frame header on the packet and a trailer. The latter serves to correct errors. At receiving end B, the frame is "unpacked" and if there is a mistake, the local computer network is not sent confirmation. This requires that the control program again send the frame to where the copy of the packer was "stored".

When the control programs read the data to addressees at all levels of subscriber system B, reverse operations are performed. Therefore the headers and trailers are sequentially ejected until there is a "clean" process A data block at level 6 which is transmitted to the interacting process B.

In local networks, the functions of the transport service (levels 2-4) are usually performed by the hardware (at the station or channel adapter) and the upper functions of the three upper levels by the programming devices in the subscriber system computer. However, there can be found varied other hardware

and programs according to the specific nature and characteristics of the network and the possibilities of the programmable large integrated circuits (microprocessors and logic matrices).

FMS integrated control systems are built on the principles of local computer networks. At this time however, the problems in designing and creating local computer networks have not been solved in their entirety and require much work on the part of specialists in computer technology, communications equipment and systems technology as well as mathematicians and programmers.

Conclusions

The leading role in converting the technical base of industry and in substantially increasing labor productivity has been played by robotization as a higher form of large-scale industrial automation. This is combined with the creation of flexible automated production performing an entire set of technological operations without human participation and quickly adjustable to changes in either the type of production or the technology used. According to the prognoses of American specialists, the production of robots will increase 35 percent each year until 1990 to exceed a value of two billion dollars. What can explain such rapid growth?

First of all, large-scale robotization of industry is practically impossible without the employment of robots. The number of industrial processes in which manual labor is either impossible or highly dangerous (in conditions of high radiation, vacuum, in outer space, etc.) has risen. Social demands on industry have changed and the modern skilled worker is reluctant to perform tiring and monotonous work.

Second, we now have the technical means to mass production use robots. The growth of electronic technology has led to the creation of large integrated circuits and microprocessors that are inexpensive and small in size and are capable of controlling industrial processes according to an assigned program. These devices have made it possible to achieve a high level level of large-scale mechanization and automation in basic industrial processes. There is a trained cadre of scientists, designers, engineers and highly-skilled workers capable of developing, producing and using complicated technology. Robotization of industry has made it possible to develop and introduce flexible technologies and modern forms of large-scale automation not only of mass production but also of small-series and individual production, auxiliary processes, design work and eventually, to create "operator-free" industries. The introduction of flexible automated systems has been made possible first of all by an acceleration in the rate of renewal and expansion of the product list and second, the high rate at which scientific and technical advances are being introduced. This has led to more rapid replacement of materials, tools and technological processes. The third aspect is the necessity of increasing production loads and extending the service life of costly equipment.

At the present time, a scientific and technical program is successfully being carried out to create and assimilate industrial robots. Under this program,

50 new basic robot models, 38 roboticized complexes and 17 robot-equipped automated shops and sections are supposed to be developed in 1985.

International cooperation is being arranged between the CEMA nations to develop and use industrial robots and FMS. At the 38th CEMA Session, there was signed a general agreement on cooperative development and organization of specialized cooperative robot production and the German Democratic Republic, Czechoslovakia and Bulgaria are working together in this area.

To the Interested Reader

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